J. Basic. Appl. Sci. Res., 3(4)675-682, 2013
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ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

The Nature in the Courtyard, a Comparison Approach in Kashan Residences

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ABSTRACT

The combination of nature and residential buildings has been considered in urban ecology and a special attention is paid to harmonization of the construction with natural context. Natural factors and specially the nature embodied in courtyards can enhance the life quality and make the residence, more comfortable.
Embracing the nature in courtyards is one of the patterns that has been repetitively applied in residences of Iran and that can be a historical pattern for new ecological designs. There have been some natural factors (light, water, air and plant) that have effectively formed the typology and morphology of vernacular architecture. Their impact is studied to some degree by the philosophy of their usage and finally by measuring the spaces that are concreted by these factors.
KEYWORDS: Kashan, introverted residence, central courtyard, nature (light, water, air and green space)

1. INTRODUCTION

The uncontrolled growth in urban population and that one in urban development, and the industrialization procedure have led to crucial change in housing designs. In developing countries, the international style in architecture has been mostly implemented in projects that are in the middle way between the traditional way and the new standards. The functional, logical and useful spaces in residences have been accompanied with the elimination of open spaces.

In some countries like Iran, before industrial revolution and fast urban growth, there has been a proper relation between the residential and natural spaces. However, according to the aforementioned factors, this relation has decreased or died out at all.

Natural spaces were frequently used in old Iranian house courtyards and now are the sources of inspiration for architects and are appreciated for preserving architectural heritage. According to the *Köppen's* climate classification, Iran is located in a dry hot weather (Trewateha, 1968); hence, the central courtyards, rather than their typological and morphological value, can help to make the residences more habitable and more comfortable. "First human residences sheltered him against wind, rain, and sun. These fulfilled the aims of saving life" (Fathy, 1993). For this reason, there has been a close relation between architecture and the climate in dry hot weather.

In order to confront the harsh situation, the urban textures in most dry hot regions have dense structures with no opening in external walls. So there are few openings that let the air transmit. The central courtyards are the main opening in the building that let this transmission happens. They result in living spaces that are more comfortable by benefitting from the natural elements (light, water, wind and green space) in a controlled way. Some good examples of residences with central courtyards are located in Kashan.

Figure 1. Aerial photo of *Ameries*, *Borujerdies* and *Tabatabaies* houses in Kashan

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In this study, Kashan is introduced as the context of houses with courtyards and then, the dry hot climate will be studied for its impact on forming the central courtyards. The characteristics of vernacular architecture in this climate will be studied and three houses will be studied more specifically: Ameries, Boroujerdies and Tabatabaies houses. (Fig. 1

2- Dry hot climate

2-1 Kashan and the climatic conditions

Kashan city is the center of Kashan commune and is located in east 51,58° and north 33,98° . Its population is 248,789 people according to the census in 2006. Kashan is 270 kilometers from the south of capital Tehran and between the Karkas Mountains and Kevir desert. It is Located on the rim of the central Salt Desert and dates back to prehistoric times. (Fig. 2)

Kashan is the 20th populated city in Iran and the 11th industrialized one, and its industry is mostly the carpet factories (more than 100 ones) and other factories (like galvanized sheets and the automobile parts)

The vicinity to Kevir has made the climate of this city dry and hot. The hot and dry weather in summers and cold and dry one in winters make the rainfall very low. The moisture is very low in dry hot climate and the plants are rare and the winds that blow from the Kevir carry dust.

One of the most important characteristics ofcentral courtyards forming process has been the compatibility with the climate for making a comfortable situation. Heideger says: “The habitation expresses a meaningful relationship between human and his living area and this relation is an attempt for identification and belonging to a place.”

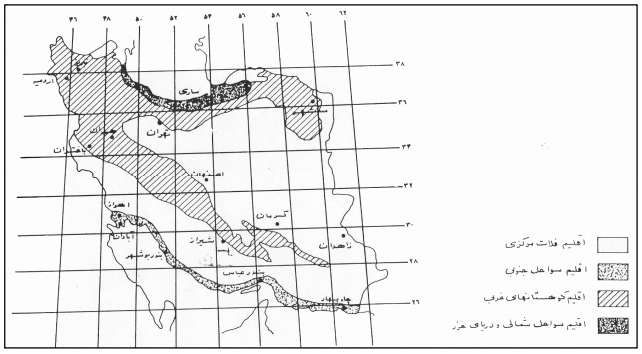

Figure 2. Kashan’s climatic situation, (Kasmaie, 2003)

2-2 Cultural and climatic factors in forming the central courtyards

Iran has been a large and ancient country, which in time of forming its architecture; it has presented a specific kind of architecture to the world. Its climate and culture has caused innovations in residential architecture. Generally, it can be said that in Iranian architecture, two kinds of architecture is followed according to the courtyard location next to residential space.

1. Introverted architecture (which is the subject of this study and discusses the courtyard formation)
2. Extroverted architecture (which is not discussed in this study and that is the green space and the courtyard around the house.)

There is no visual relation between interior and exterior places in introverted architecture and there is no openings toward the streets and paths and if there is any, that will be in a height that no view to interior space is possible. There have been some effective elements in the formation of this architecture as below:

2-2-1 Region

Region is one of the most important factors in forming the central courtyards in dry hot region. In this region, because of dry hot weather, sunlight, and specific climatic conditions, the old parts of cities are dense. “This density prevents the sunlight to enter. The walls and ceilings are generally thick in order to protect the interior spaces from outside heat.

The city structure is designed in a manner thatthe arteries become closed to the unwanted winds and sandstorm. (Tavassoli.M.1974) The density in interior spaces transform to openings and in this way the central courtyards emerge. The regional factors affect the formation of courtyards in two ways: First, the building orientation ends to a better climatic condition and it affects the orientation of courtyards, and second, the buildings become introverted for sheltering from harsh regional conditions and the best condition is provided in courtyards.

2-2-2 Building orientation

One of the most effective factors in enhancing the climatic conditions has been the orientation of building on the north-south axis and it has affected the central courtyards orientation (Fig. 3).The main purpose of orientation in dry hot region is minimizing the harsh sunlight in summers and decreasing the daily temperature in interior spaces and maximizing the sunlight in winters. (Givon,B,1976)

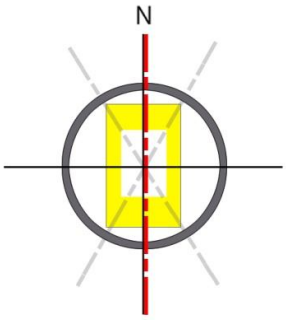

Figure 3. Best common axis for many houses in Kashan

2-2-3 Introversion

A great proportion of houses are designed to keep the residents away from harsh climatic conditions. Dry and hot weather, little rain, and the storms that carry sands and dusts, all make the house introverted. The focal points of these houses are the central courtyards enclosed in the dynamic and live body of house. The main composition of these buildings is the open space (central courtyards) that is mostly formed by the bodies of the building. Norberg schulz names this composition "the principles of forming the open spaces with building framework", and believes that these principles can define the open spaces (central courtyards) better. (Norberg Schulz, 2001)

In these designs, the accesses are in a special mood. "The access points to the houses areout of direct vision and the building front faces the enclosed courtyard. (chermayeff, Christopher, 1992). So the living is current in the interior parts of house.

2-2-4 Culture

Culture has affected the archaic urban textures. The houses with central courtyard has been some prominent elements in most Muslim cities. "The study of Muslim cities verifies that these cities are mostly located in dry hot regions. The cities formation and organization harmonized and balanced the human needs with man-made and natural areas; The Muslims tried to make a harmonic, balanced and habitable city space through knowing the natural elements and using the nature rules.

The private garden related man to nature. The gardens were in the courtyards and were general in most Muslim cities. (Aminzadeh 2000) Hasan Fathi says about the destroying of green spaces in Cairo houses: "The central courtyards in old Cairo which were the prominent element in the compositionof houses for thousands of years, have acted modestly like the lungs of the city and whilst filtering the dust of air, provided oxygen for it;nevertheless they were the first sacrifices of modernization.(Steel,James,Hassan Fathy,1989)

One of the impressive cultural thoughts was keeping the realm of family out of the reach and vision of strangers. Considering the family was one of the crucial points that have affected the formation of introverted houses after Islam. Of course the first courtyards go back before Islam. But Islam had an impact on the minds of Iranian designers by sanctifying the realm of family. That is why in harsh dry hot climate, there has been a safe sanctum for families beside a habitable area for living. Sometimes these courtyards did not limit to one, and they were repeated in several parts of the house.

2-2-5 Spatial organization of central courtyards

As mentioned before, there were sometimes more than one courtyard in houses. In big houses with two courtyards, the interior courtyard which was bigger was called *Andarouni* and it was dedicated to the nearest members of family [*mahram*];The second courtyard which was generally smaller than the first one was dedicate to masculine guests. There has been a big room between the two courtyards which was named the *dorou* (with two faces)

"The courtyards, in addition to unification of spaces, make a circulation between them, this relation begins from the building entrance, and in cases that the courtyards are located in different summer and winter spaces, and they relate different parts of house. Using the green spaces and making the pools in different shapes in the

courtyard, make a scene for the habitants in the rooms, salons, and a sitting area in hot sunset times. (Memarian, 2005)

Of course it should be considered that the courtyards in cities like Yazd, Shiraz, Isfahan, Kashan and Kerman acted like little gardens. (Pirnia, 2010, p.161) Some of the characteristics of houses' open spaces were the geometric organization and using of simple, familiar, balanced and eligible forms in order to make a tranquil place for habitants. This enclosed open space was one of the important elements in harsh climates of Islamic cities; it provides the best spatial comfort with respecting the privacy, and spiritual needs. (Aminzade, 2000). Three typologies are shown below based on the number, location and the shape of courtyards. (Fig. 4)

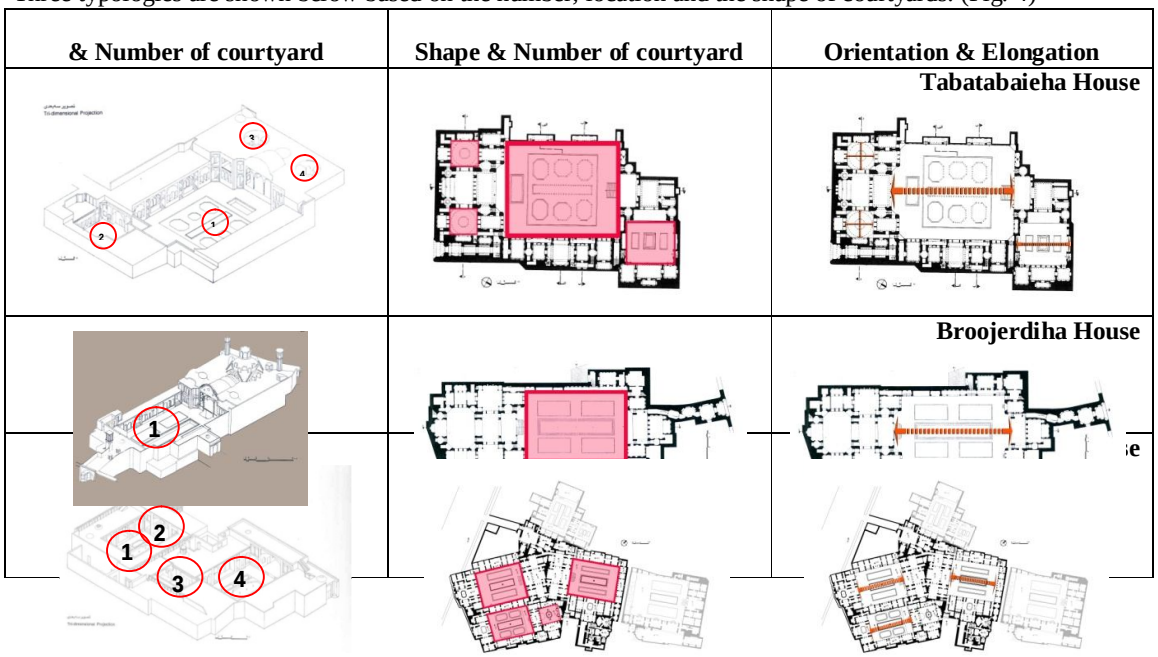

Figure 4. The courtyards in *Ameries*, *Boroujerdies* and *Tabatabaies* houses

1- The elements affecting the spatial formation and organization of central courtyards

One of the common characteristics of different structures in Iran is their conformity with the climatic conditions. The factors that affect the climatic condition in a region are the sunlight angle, the longitudinal specification, the seasonal winds, water, moisture and plant in the region. In this study, four vital natural elements that have most affected the spatial formation and organization are taken into consideration. These elements respond to some physical, secular, spiritual and psychological needs of human and they will be mentioned briefly.

3-1 Light and sunlight

The central courtyard is the focal point of houses in dry hot climate. This space shelters the residents from the annoying harsh sunlight in summer and helps the mto get it in winters. This light gives beauty to the central courtyard. The glowing sunlight on the pools, in addition to visual beauty, makes the atmosphere more comfortable and control the moisture in the air. The sunlight is discussed in two aspects: first the physical and climatic and second the spiritual and cultural aspects.

3-1-1Physical point of view

The sunlight is an important factor in this climate. Radial transition is the most important factor that controls the climate, because that is the ultimate cause in changes in the atmosphere. Every climate acts as the result of obtaining or missing the heat via radiation. (Lamb, H.H, 1979)

3-1-2Cultural and spiritual point of view

Light has a grand meaning in Iranian Islamic point of view. It has been mentioned in Muslim's holy book as the symbol of unity, the symbol of prophet of Islam, of the holy book of god, of the faith and deliverance, of guidance, and of insight. In addition, in cultural aspect, the light that passes through the leaves of trees makes a contemplative divine atmosphere.

3-2Air and wind

The air temperature is affected directly by the sunlight. The main source of energy is the sun. The air and the earth can absorb this radial energy and transform it into other sorts of energy. (Trewateha,G.T,1968) The wind is another important factor that besides the sun, control the temperature and the moisture of air in the courtyard. "Wind is mostly controller of the rainfall and temperature and because of its effects on evaporation, it affects the temperature." (Trewateha, G.T,1968)

The courtyard has an important role in encountering the sunlight and controlling the temperature with the wind. Dunham describes it: "When night arrives, the hot air goes up and is replaced with the cool air that already exists on top of the house. This cool weather is saved in the thin walls of the courtyard and then transmits to the rooms and the spaces around the courtyard. In the morning, the air in the courtyard heats and the coldness rest until the sunrays directly shine into the courtyard. The hot daily winds do not enter the courtyard and just make some ventilation in the courtyard.(DUNHAMM,D.D,1960) (Fig. 5)

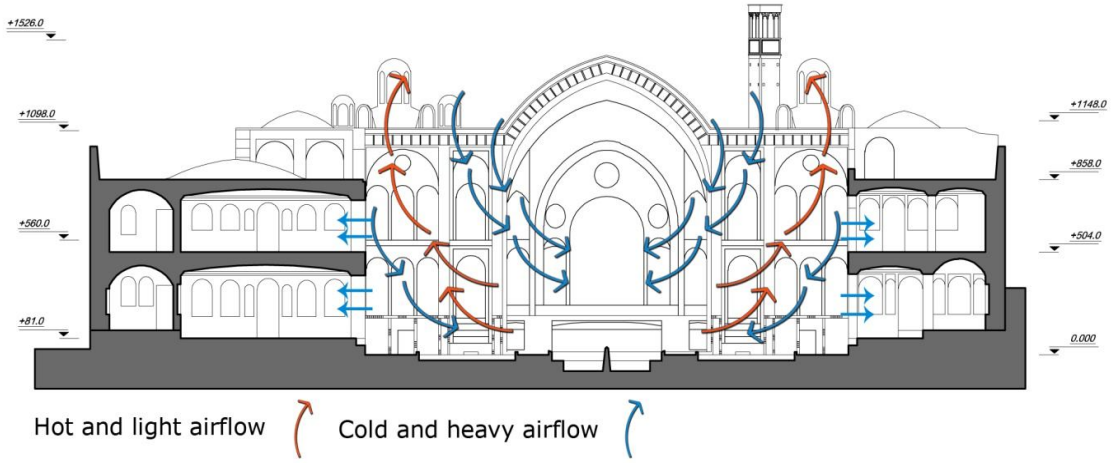

Figure 5. Typical air circulation

3-3The moisture and water in the courtyard

The moisture is the rate of water in form of gas that exists in the atmosphere or in another word that is the vapor in the atmosphere. The courtyard has provided the security, privacy, and comfort for the habitant. There are usually sunken gardens in courtyards that varied flowers and trees are planted there; there are also shallow pools that besides the beauty help to the favorable condition in courtyard by making shadows and increasing the air moisture. Therefore, they are some of the principle elements for natural cooling. (Bonin, M.E,1980)

Water is important in central courtyards as well, and at it plays a great role in increasing moisture and cooling. "The thermal capacity of water is generally more than other materials on the earth. So water can save more heat rather than other materials. Hence, in macro climate scale, it can balance the temperature of a region in different hours of the day and also in micro scale, it can decrease the temperature in the interior parts of the house. One of the reasons that water is frequently found in desert houses is to increase the air moisture and make the interior atmosphere comfortable. (Ghobadian, Vahid, 2005)

Water is of great importance in Iranian Islamic culture too. Water is as the symbol of life, of paradise, of purity, of beauty and of virescene.

3-4 Plant and green space

One of the elements in central courtyards is the green space. The space provides the hygiene of the residence and it causes the health of residents. Actually the green space has physiological and the psychological impact.

Plant has a symbolic role besides the shadow and beauty it presents to the courtyard. In Islamic instructions the plants are described as the elements of paradise.

2- RESULTS AND DISCUSSION

In the maps below, the spaces dedicated to water in central courtyards of Ameries, Boroujerdies, and Tabatabaies houses are shown. (Fig. 6)

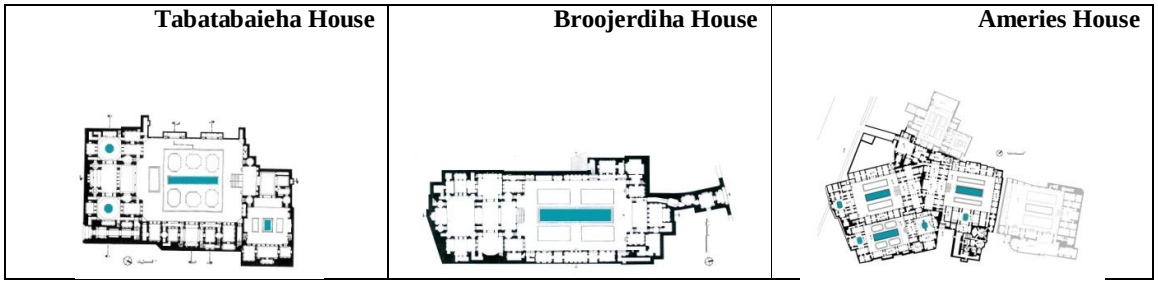

Figure 6. The waterfront in *Ameries*, *Boroujerdis* and *Tabatabaies* houses

Waterfront area	Courtyard area		Houses
15.22	212.44	A	Bakouchi
20.5	251.51	B	Abasian
23.75	315	C	Tahami
25.7	339.4	D	Dastmalchi
36.5	351.5	E	Atars
53.2	446.61	F	Isfahanis
25.8	470.31	G	Al-e-Yasin
73.5	537.1	H	Reza Hosseini
77.7	566.3	I	Sharifian
103.5	644.7	J	Boroujerdis
113.52	921.06	K	Banikazem
69.5	940.5	L	Tabatabaies
296.62	1748.09	M	Ameries

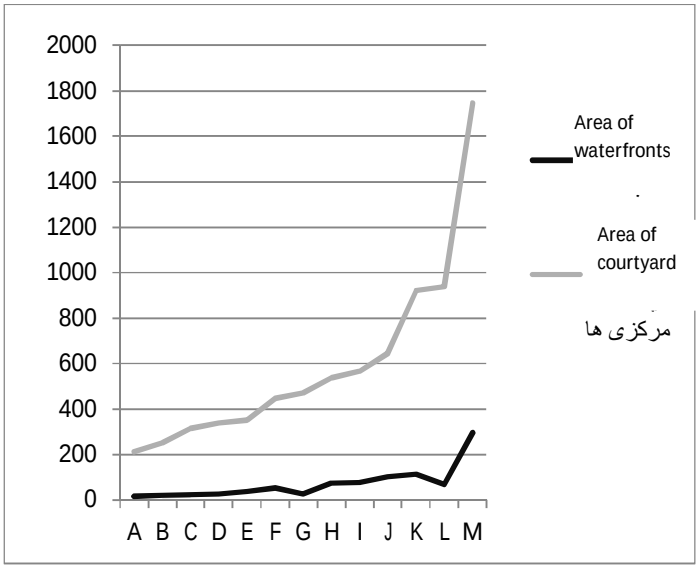

Table 1. The change in the area of waterfronts in proportion to the change in the area of courtyards

As it is shown in the table (Table 1), with increasing the area of central courtyards, the area of waterfronts are increased. However, the gradient shows that growth was not as strong as that one in courtyard area.

The maps show the green spaces in Ameries, Boroujerdis, Tabatabaies central courtyards. (Fig. 7)

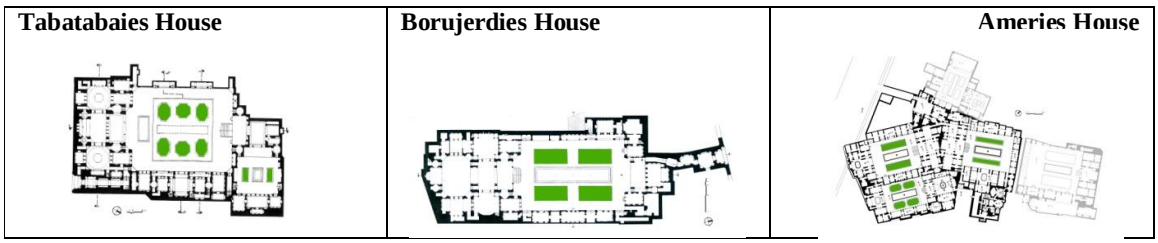

Fig.7 The green space in *Ameries*, *Boroujerdies* and *Tabatabaies* houses

Green space area	Courtyard area		Houses
65.12	212.44	A	Bakouchi
72.7	251.51	B	Abasian
47.5	315	C	Tahami
75.4	339.4	D	Dastmalchi
51	351.5	E	Atars
48	446.61	F	Isfahanis
98.48	470.31	G	Al-e-Yasin
127.2	537.1	H	Reza Hosseini
203.5	566.3	I	Sharifian
152	644.7	J	Boroujerdis
212.8	921.06	K	Banikazem
115.22	940.5	L	Tabatabaies
257.39	1748.09	M	Ameries

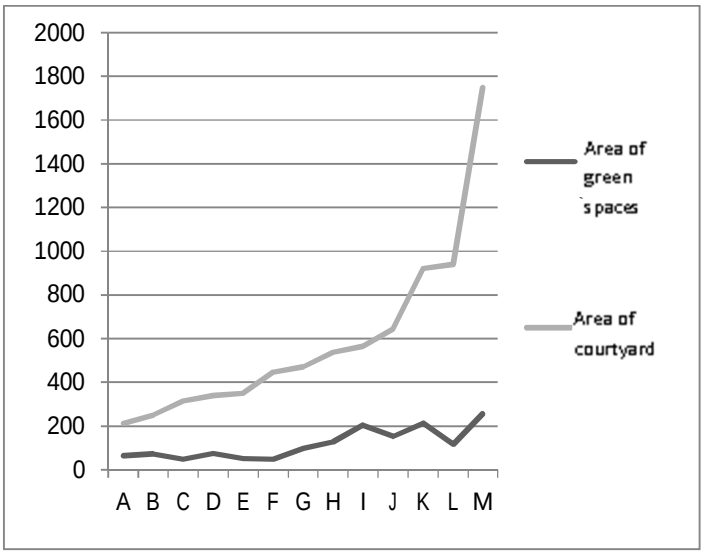

Table 2. The change in the area of green spaces in proportion to the change in area of courtyards

As it can be seen (Table 2), with increasing the area of central courtyards, the green spaces increase too. Although the area of courtyards were different enough, the difference in area of green space was not so noticeable and even in Tabatabaies a noticeable fall in the area can be seen.

Waterfront area	Green space area		Houses
23.75	47.5	C	Tahami
53.2	48	F	Isfahanis
36.5	51	E	Atars
15.52	65.12	A	Bakouchi
20.5	72.7	B	Abasian
25.7	75.4	D	Dastmalchi
25.8	98.48	G	Al-e-Yasin
69.5	115.22	L	Tabatabaies
73.5	127.2	H	Reza Hossein
103.5	152	J	Boroujerdis
77.7	203.5	I	Sharifian
113.52	212.8	K	Banikazem
296.62	257.39	M	Ameries

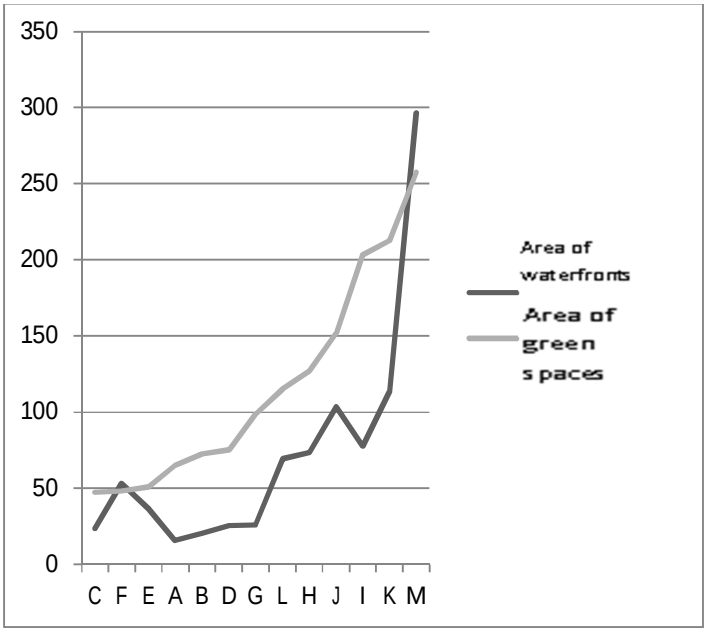

Table 3. The change in the area of waterfronts in proportion to the change in area of green spaces

In this graph (Table 3), there is a comparison between the increase in the area of the green space and the space dedicated to waterfront in courtyard. As it is shown, with increasing the green space *apriori*, the area dedicated to waterfront do not show a noticeable increase and even shows decrease. (Attars and Bakuchis house) but as it continues, with increase in green space area, the areas for waterfront increase to the extent that in Ameris house has become more than green space.

3- Conclusion

According to the diagrams, the courtyards in most of old houses in dry hot weather (Kashan) show that:

With increase in the area of the courtyard, the area of the green space and waterfront has increased in a slower rate. That could be affected by the lack of water and the difficulty in planting and reserving the green space.

The spaces that are mostly focused on are the family spaces. They serve forgathering the family members. They redesigned by anticipating the needs in house with regard to the climatic conditions. Rather than the comfort and beauty that is the result of using green spaces and waterfronts, the enclosed spaces of courtyards are appreciated by themselves, because the changes on the scenes, visions and climatic conditions are more easily applicable in these spaces.

Since there are many residential buildings that have more than one courtyard and the number of courtyards can somehow show the importance of the building *a priori*, and the importance of each part of the building can be shown by the area of courtyards *per capita*, the dispersion of courtyards in different parts of building will be studied in the future.

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