



**Climate Elements Impact on Heritage
Houses Spaces Formation in Baghdad
(Districts of Kadhimiyah , Adhmiyah , and
Kerkh as models)**

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The study is on Climate Elements Impact on Heritage Houses Spaces Formation in Baghdad Kadhimiyah, Adhamiyah , and Kerkh as case study models .

The study defined the problem of the research by discussing natural factors impact on traditional architecture formation in Baghdad. It also discuss the harmony, accordant, and compatibility of traditional architecture with climate factors as far as climate change impact on building design and its elements formation are concerned. The study aims at having a compatible climate environment. The study includes three main sections:

First:

The theoretical framework

Second:

The climate elements characteristics in Baghdad

Third:

Climate elements impact on the formation of spaces for traditional Baghdadi house.

The study also includes a conclusion of the most important results. One of these most important results is that the heritage designer had made, from the heritage house spaces, different functions to serve the habitant of the traditional houses. The study suggests, as best, that efforts should be paid on preserving the Baghdadi civilized inheritance, which represents the Iraqi civilization spirit.

Introduction

The study is devoted to explore the effect of climatic elements such as solar ray, temperature, rain, and wind which have main effect on the human and his environment.

The study is also devoted to measure the harmony of traditional architecture in Baghdad and its interaction with the elements in terms of climate impact on building design and the formation of its elements. This measure should lead to have a comfortable interior environment as far as the design that could define the relation between the climatic treatments and the comfort of inhabitants of Baghdad heritage houses.

The traditional architecture, done by the designer in determining the relationship between climatic treatments and the comfort of inhabitants of Baghdad heritage houses, of whichever area is subjected to the climate effects of that area.

This traditional architecture attempts to solve such problem using building materials from the local environment that adapt with the existing climate of that area. The materials reduce the climatic effects on the inhabitants of such traditional units that provide bioclimatic environment. This is done by using vertical air holes and cellar to reduce temperature in summer. Another way to reduce humidity and to have a reasonable temperature in winter is paving the roofs of the house with timber. Through the field study there are heritage houses preserving their structure in the study area since 1700. These houses have all climatic treatment means due to continuous maintenance.

The researcher divided the research into three main sections:

The first is about the theoretical framework.

The second is on climate elements characteristics in Baghdad.

The third is on climate elements impact on the formation of spaces for the traditional Baghdadi house.

The first section: the theoretical framework

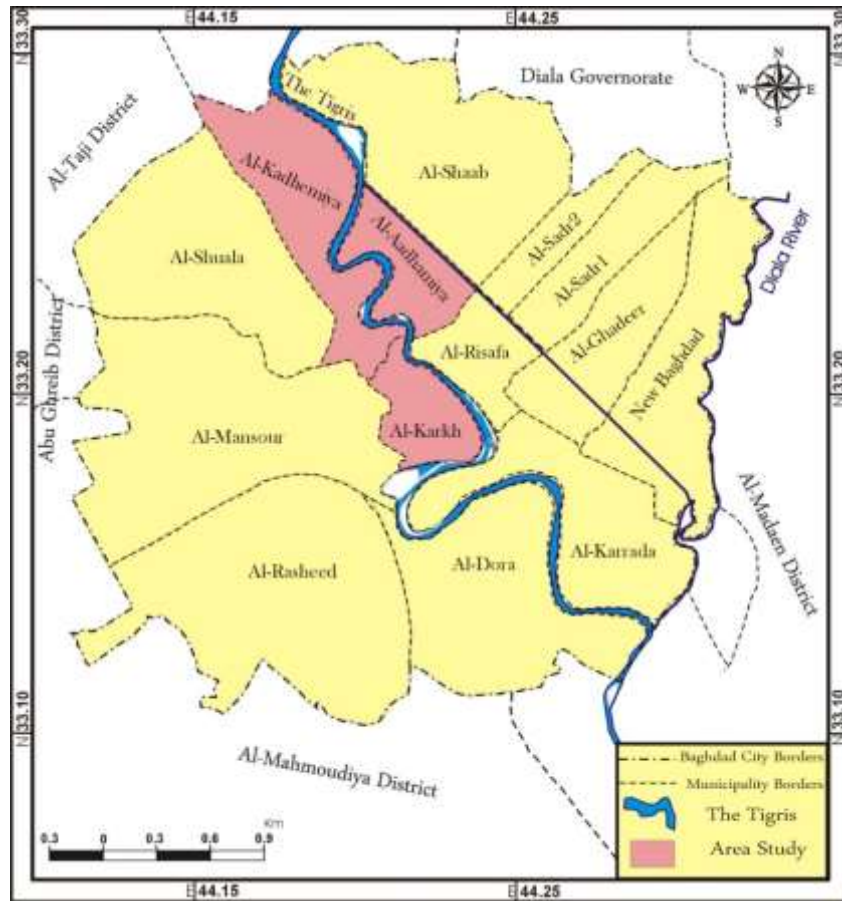
1-1-1 : Limits of study: spatial and temporal boundaries

Spatial boundaries: Baghdad traditional district areas of Kadhimiyah, Adhamiyah, and Kerkh, as in map (1).

Temporal boundaries: inherited house units between (1870-1921).

Map (1) Study Areas

*Ref: by the researcher based on Geographical Information System
Unit Baghdad Municipality,2018.*



Research Problem:

1-1-2: Natural factors impact on the formation of traditional architecture in Baghdad.

1-1-3: Research assumption:

The natural factors impact on the formation of basic design of the heritage house. The assumption gives the functional impression of the heritage house, which was characterized by an architecture that is in harmony with natural factors.

1-1-4: Research Objectives:

First: recognize the internal design of traditional architecture, its coherence with local environment and human adaptation within them and the principles, bases and standards by which they were designed.
Second: Have a complete image in accordance with comprehensiveness and conciseness on natural factors impact on the formation of traditional architecture.

1-1-5: Importance of research:

The research is based on conservation of heritage houses by inhabitants and to keep them from the natural factors effect.

1-1-6: Why this subject?

The reasons to choose such subject are:

1. Lack of previous studies on the climate elements impact on the formation of traditional housing spaces.
- 2- Remind heritage competent authority to take responsibility as far as maintenance and conservation of traditional heritage are concerned so as to protect such houses from being damaged due to natural and human factors.

1-1-7: Research method:

Good results were depended on field survey and analytical approach to analyze such phenomenon precisely.

1-1-8 Research plan:

The research consists of an introduction and divided into three main sections: the first is on the theoretical framework. The second is on characteristics of Baghdad climate. The third is on the climate impact on the formation of spaces of the traditional Baghdadi houses.

The second section: characteristics of climate elements

The Baghdadi designer has played a main role in reducing climatic elements impact such as solar radiation, solar brightness, temperature, humidity, rain, and wind. Architecture is subjected to the existing environment effects of such region. (*Haidar Abdul Razzaq Kamuna, 1989, p. 10*). Therefore, the old heritage structure is a reflection of the prominent climate circumstances as far as street patterns, narrow paths, internal designing of house units planning, and quality of materials used in construction are concerned.

In addition to the prominent climate circumstances, the wind movement, and the daily, seasonally, and annual rates of temperatures have effects on the old heritage structure. (*Haidar Abid Jouda, 2002, p. 210*). The climatic elements in the study area are as follow:

2-1-1: Solar radiation and solar brightness:

Sun radiation is the main source for heating the Earth's surface. It reaches the earth surface and bounce back to the lower layers of the gaseous atmosphere. (*Ali Saalim Ash-Shwawra, 2012, p. 6*)

Radiation is also an environmental factor that mainly affects the construction materials, whose wavelengths are ranged from the visible, infrared and ultraviolet wavelength of the sun, reducing heat to the building). The construction materials differ in absorption of wavelengths. They absorb a rate of the radiations and reflect the other. This rate is called the absorption ability. The effect of the sun at daytime is made by short and long wavelengths radiation and the loss of heat during the night is made by long-wavelength radiation.

Structural materials are heated by radiation in three ways:

- 1-Direct radiation on walls where solar energy converts into static thermal energy inside the material.
- 2-Thermal conductivity on the materials attached.
- 3- Thermal convection, temperature difference between inside and outside (*Feiden, 1982, P.92*). Thus, we note that the shadow parts of the building maintain lower and constant temperature. The structural materials are expanded when they exposed to heat and contracted after the loss of heat. This characteristic is called thermal expansion and contraction. The Baghdadi houses designer used the structural materials of the local environment which resist the heat comes from solar radiation and brightness.

The amount of radiation on the study area could be known by determining the actual theoretical solar brightness hours. The theoretical brightness, the average length of daylight hours, depends mainly on the earth's rotation around itself (*Ahmed Ash-Sheikh, 2004, p.42*). The actual brightness is the period of sun light during the day (*Ali Hassan, 1982, p. 15*).

Table (1) shows the temporal and spatial variation of the theoretical and actual brightness hours in the study area. The variation of day and night period in different seasons depends on solar radiation exposure.

Table (1) Average monthly brightness hours

(theoretical and actual) for the study area hour / day Period(1984-2018)

month \ Brightness	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Theoretical brightness	10,13	11,00	11,08	12,00	13,04	14,20	14,07	13,23	12,18	11,18	10,29	9,06
Actual brightness	7,2	7,2	7,7	8,0	9,9	11,7	11,6	11,4	10,1	8,1	7,0	6,0

Ref: Ministry of Transportation and Communications, Iraqi Meteorological Organization and Seismology, Climate Department, unpublished data, 2018.

Table (1) also show that the lowest theoretical brightness is in December and January (9,56 , 10,13) hour/day. The highest daylight rates were recorded in June and July (14.20, 14.07 hour / day). The highest actual brightness were recorded in June (11.7) hour/day. The increase or decrease in the values of the actual hours of solar brightness of the study area with the values of increase and decrease in the amount of solar radiation which leads to the long period of thermal gain so as to have increasing in the temperature of the city.

2-1-2 : The Temperature

Baghdad is located within the desert climate, which is characterized by high temperature in summer and low one winter.

The temperature is an important factor affecting the atmospheric pressure, wind, and precipitation. It is related to the atmospheric disturbances (*Ghazi Sa'adallah, 1989, p. 155*). The hottest months in summer are July and August with (35.4 C° and 34.7 C°). The coldest month is in January with average temperature of (9.7 C°), Table (2) and Figure (1).

Some of the materials of the Baghdadi Heritage House are reasons for summer temperatures variation such as building materials, soil, plants, and herbs. Each material has a reflectivity characteristic, which differs in heat gaining and losing (Albedo) (Salah Hameid Al-Janabe, 1997, p. 35). Field study and visual observation show that the temperature does not enter into the heritage house considerably because the wall is thick and the structural materials are from the local environment.

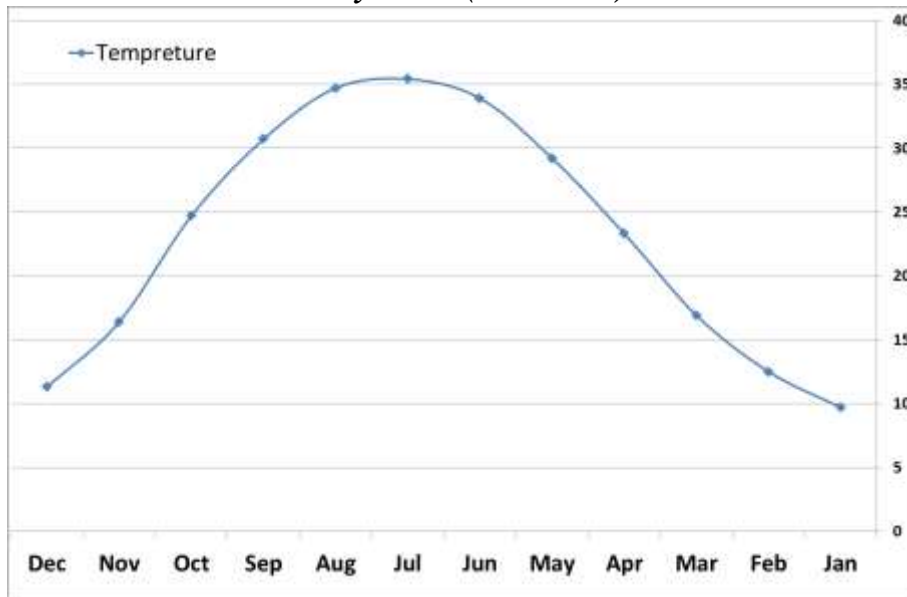
Table (2) Monthly and annual rates of temperature (C°) for the study area

hour / day
 Period(1984-2018)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rate
Temperature	9,7	12,5	16,9	23,3	29,2	33,9	35,4	34,7	30,7	24,7	16,4	11,3	23,5

Ref: Ministry of Transportation and Communications, Iraqi Meteorological Organization and Seismology, Climate Department, unpublished data, 2018.

Figure (1) Monthly and annual rates of temperature (C°) for the study area hour / day Period(1984-2018)



Ref: The work of the researcher based on table (2).

2-1-3: The Wind

Wind speed varies on the ground due to friction against topography which weaken it and be discontinuous and consecutive (Mohammed Sabri Mahsoob, 1960, p. 140). The wind speed also varies due to different atmospheric pressure. Table (3) show the lowest annual rate of wind speed in the study area is (3.1) m/s. The lowest monthly average is in January (2,5) m/s. The field study and interviews prove that the wind does not affect on houses where it enters the heritage house units through the courtyard and the basement through the wind catcher hole. On contrast it is also proved that the wind could affect on such houses if they do not go under annual maintenance. The wind has a main role on heritage house parts, such role would be given in details in the climatic handling. (The field study of 2019).

Table (3) Monthly and annual rate of wind speed (m / s) for the study area hour / day Period (1984-2018)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rate
influents	٢,٥	2,9	3,2	3,2	3,4	3,9	4,2	3,3	2,8	2,6	2,5	2,5	3,1

Ref: Ministry of Transportation and Communications, Iraqi Meteorological Organization and Seismology, Climate Department, unpublished data, 2018.

2-1-4: Humidity and Rain.

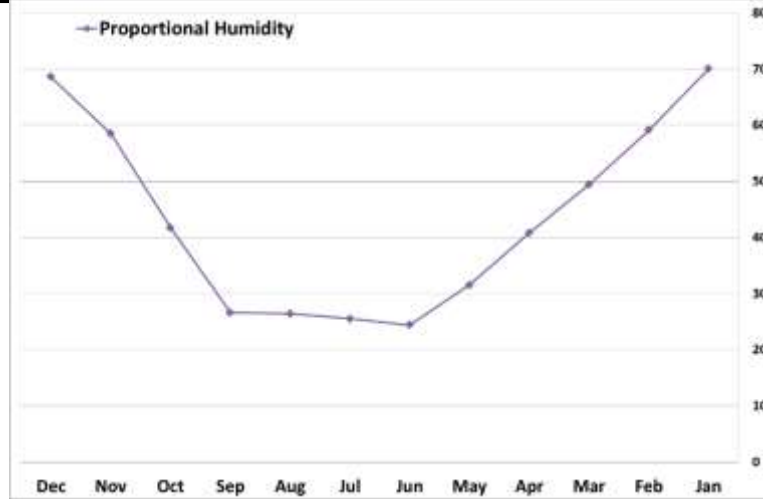
Humidity is the concentration of actual water vapor in a certain air volume at certain temperature in relative to most amount of air could be absorbed at same temperature. It is measured in percentage. (*Quasy Abdul-Majid Al- al-Samarraee, 2008, p. 2010*). Humidity is considered to be an important element in falling as quantity and quality. It affects the characteristics of wind and the degree of its dryness and its humidity. It also has an impact on the physiology of human and animal bodies and on urban growth as well as their impact on the quality of clouds. Its quantities determine the solar radiation amount falling on earth and temperature values (*Ahmed Saeid Hadid and Fadhil Baqer al-Hassani, 1981, p. 145*). The field study shows that humidity increases in summer in the basement. It moves from the bottom of the insubstantial walls, no concrete included, and provide a cool climate. In winter the percentage of humidity increases in the structures of the walls that consist of brickwork, gypsum, and mud. Table (4) output show that the relative humidity has a significant effect in December and January with 68.6% and 70% respectively. Although the rains are not as much in the study area, they are of Mediterranean climate and keep on falling from October until the end of May. There are heavily fall in some seasons, especially when the rains coincide with the intensity of the wind where they fall on the structures of heritage houses. But the rain does not affect on the heritage building because the oriel windows, landed with 50 cm off the building , protect the walls and the pedestrians who walk in the narrow paths. Table (4) output also show that the maximum rainfall in the study area is in January (25.5) mm and decreases in October with (4.6) mm. The total annual rainfall is of (117.9) mm.

Table (4) Monthly and annual rates of annual humidity (%) and total rainfall (mm) in the study area / hour / day , for the period (1984-2018).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rate
influents													
Proportional Humidity	٧٠	٥٩,١	٤٩,٤	٤٠,٨	٣١,٥	٢٤,٤	٢٥,٥	٢٦,٤	٢٦,٦	٤١,٧	٥٨,٥	٦٨,٦	٤٣,٦
Rains	٢٥,٥	١٤,٨	١٤,٤	١٤,٧	٣,١	٠,٠	٠,٠	٠,٠	٠,٣	٤,٦	٢١,٢	١٧,٩	١١٧,٩

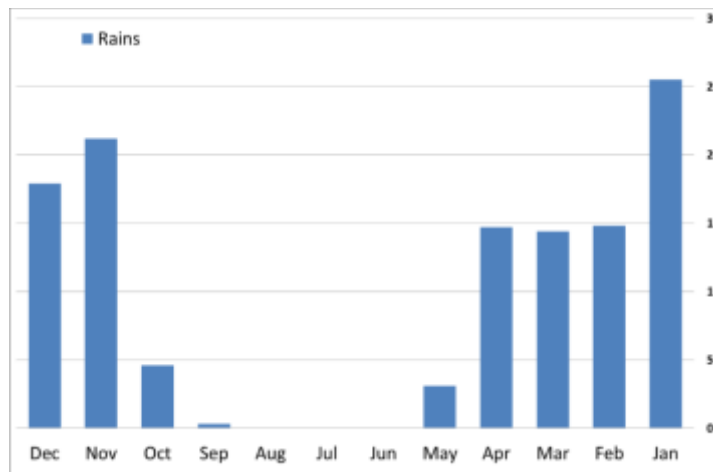
Ref: Ministry of Transportation and Communications, Iraqi Meteorological Organization and Seismology, Climate Department, unpublished data, 2018.

Figure (2) Monthly and annual rates of annual humidity (%) in the study area,(1984-2018)



Ref: The work of the researcher based on table (4).

Figure (3) Monthly and annual rates of total rainfall (mm) for the study area hour / day Period (1984-2018)



Ref: The work of the researcher based on table (4).

The **De'Martonne** equation could be applied in tables (2) and (4). In this equation **De'Martonne** divided the world into five regions based on the drought coefficient as in the following:

i = drought coefficient

$$i = \frac{N}{T + 10}$$

$$i = \frac{117.9}{23.5 + 10}$$

N = rainfall rate (mm)

T = annual average temperature (C°) = 3.5

According to data in tables (2) and (4)

De'Martonne equation showed that the climate of the study area is dry and within the thermal area of Baghdad Al-Rawi, (*Adil Saeid, Qusay al-Samarraee, Applied Climate, Baghdad University, 2005*).

3 - Section Three: environmental treatments in traditional housing in Baghdad.

The climate plays a main role in the formation of traditional Baghdadi house spaces in order to create an atmosphere of thermal comfort for its inhabitants. This idea is based on the results of the spaces that contribute in forming a less harsh climate in its impact in summer or winter. This has an impact on the physiology of human body and his psychological status. The spaces of these houses were highly designed

according to trial and success method. This method led to this product by inhabitants agreement on its reasonability for the study area.

Spaces design of Baghdadi houses depend on the nature of the common climate of the region. The designer idea is important in taking the climate situation into consideration. This is done to achieve the anti-reaction and to challenge the harsh environment so as to be reasonable. These spaces consist of the following:

3-1-1: Bent Entrance (Bent corridor)

It is a roofed corridor links between the inside of the heritage house and the outside through a corridor up to the inner courtyard. There is a main door in the beginning of the entrance which is different in shape and size. The corridor is in square or rectangular shape. The roof of the entrance differs from one house to another. Some of them are wooden columns placed on opposite walls of the corridor. The roofs are aligned by wooden panels covering the spaces left. Another section is built with brickwork in a low dome shape. To bring light to the corridor the designer put a window so as to be overlooked the basement. The corridor has several benefits:

- The owner of the house has a nap and takes water from the watering.
- Keep the house away from noises of the street outside the house.
- It is a barrier that prevents the entry of air flow inside the house.

(*Salema Abdul-Rasool, 1987, p.16*).

3-1-2: The open inner courtyard (inner courtyard)

The most important characteristic of the Baghdadi heritage house is the open inner courtyard. It is surrounded by most house units.

The inner courtyard is an Iraqi design since the Babylon age (2000 B.C) and remain discovered in the houses of the UR city. (*Hakim, 1986, p.95*).

Through the field study of heritage house units, it is found that the inner courtyard is in a square or rectangle shape. All family activities and movements are carried out around in the ground floor units. The courtyard has many advantages:

- Distributing the air and the sunlight into the house through doors and windows.
- The inner courtyard is used to greet guests at different events.
- The floor of the courtyard is lower than the surrounding units and the aim is to prevent rainwater from entering the surrounding units of the house.

3-1-3: The Iwans

Iwan is the largest area in the Baghdadi House. It is walled on three sides, with one end entirely open. It has many advantages such as:

- Providing a convenient place for the family in summer and winter and preventing rain from reaching the heritage house units.
- Entering light and air into rooms protect Baghdadi house units from direct sunlight.
- Providing a suitable fresh air in summer and winter through many air paths inside the walls (*Jassim Aziz Al-Hajjia, Baghdadiat, Baghdad, 1967, p. 68*). The Baghdadi designer put traditional house components upon climatic and social factors and provided local construction materials in that period. This had formed the authentic Baghdadi heritage, which is a core reference and a school for future generation to be taught the history of Iraqi architecture.



3-1-4 : Basement:

The climate factor is considered to be the reason for the construction of basement, which is characterized by low temperatures in summer. Some studies have confirmed that temperatures are lessening by three degrees Celsius inside the basement. The family uses the basement to spend time at hot summer days due to low temperature. In winter the family uses it to store ration. Field study and visual documented observation and images show that the area of the basement is vary from house to house and generally the length is (5-6 m) and the width is (3-4 m) with depth of (2-2,5 m).

Building the basement is carried by paving the floor of the with brickwork and the roofs are built with brickwork an gypsum. It is done by making bent arches between two sides to form circular dome, figure (2) of the heritage unit in the city of Kadhimiyah (*Salema Abdul Rasool, p. 29*).



Image (2) the basement of the heritage houses (Kadhimiyah)

3-1-5: The Wind Catcher:

A wind catcher is a reverse walls as a tower from the top of the building in square shape with a height of (1-1,5 m) above the level of the first or second floor and contains holes towards the north and north-west winds. It draws air from the holes to the distributors which in turn spread the air to the whole house. The main action is to facilitate the movement of air continuously in summer to create natural comfortable ventilation the house (*Mona Salman Mohammed, 2001, p. 8*).

The wind catcher has the following advantages:

- Makes temperature lower in summer.
- Keeps foodstuff fresh and maintain durability through potted water pool with a wind catcher hole above it to create cool water ventilation (Field Study, 2019).

3-1-6: The Ursi:

The ursi is part of the Baghdadi traditional house. It consists of many rooms on the second floor. Each front of these rooms is formed of colorful wooden windows called (glass window) and overlooking the courtyard. The origin of this lexical word is Turkish means (Dar Chair) (*Hamed Sadiq Salman, 1976, p. 256*). The rooms are of low roofs so that one who entered has to bow to sit in it. The inhabitants use it to spend their leisure time at the afternoon and to drink tea in winter. It has beautiful curved shape and small door.

3-1-7: The Oriel Window (Shanashil):

An oriel window is considered as one of the most important features of the Baghdadi Heritage House. The carpets vary from one house to another depending on the financial possibilities of the owner of the house. The decorated oriel window (Mashrabiya) is deferent in beauty upon the living standard of the owner. This oriel window, with small projecting windows on first or second floor, is an aesthetic element landed on alleys and streets.

Image (3) reflects an aesthetic necessity in its decoration and provides a visual view of what happen in the alley. It prevents seeing passerby's (*Khalis al-Ash'ab, 1982, p. 10*). The benefits of the oriel window are:

- Provides a shadow and protection from sunlight and rain for the pedestrians in alleys and streets.
- provides climatic atmosphere in summer as far as air and sunlight entering the courtyard are concerned .
- The heritage house attributed with an open overview, inside and outside, through the oriel window (*Aqeel Nuri Mulla Howish, 1989, p. 40*).



Image (3) Oriel Window (Shanashil) Heritage Houses (Kadhimiyah)

3-1-8: Construction Materials:

Construction materials, from the local environment, are used by the Baghdadi designer. These materials are the base for climate treatments in the Baghdadi heritage house: The materials are:

1- Materials used in-house:

The designer used gypsum, mud, wood, and brickwork due their availability in local environment. These materials are characterized with less heat or cold absorption and have much have an effect on air ventilation inside the heritage house especially on heat and humidity. This process in ventilation depends on the ability to store various energy as far as the capacity and heat transfer are concerned (*Ali Ghanem Ahmed, 2010, p. 113*).

Field study shows that most of the heritage houses, which are built of gypsum, mud, wood and brickwork, are having reasonable heat in summer and winter. This is not the case with stone and cement houses, where thermal transfer is fast and the walls are heated in summer and emitted it at night and the opposite happens in winter at day and night. The construction materials differ in physical properties in terms of density, heat capacity and thermal transfer from. Table (5) shows that the wood is the least material for thermal transfer (20%) and gypsum (46%).

Table (5) Physical Properties of Construction Materials

Building Materials	Density Kg/m ³ X 10 ³	Heat Capacity Jol /m/Kg per million	Heat Conductivity Watt.M ² /C ⁰
Plaster Stone	١١,٢٨	١,٤٠	٠,٤٦
Mud	١,٩٢	١,٧٧	٠,٨٤
Wood	٠,٥٢	٠,٩	٠,٢٠
Brickkiln	٠,٨٣	١,٣٧	٠,٨٣

Ref: The work of the researcher based on Ahmed Ghanem, 2010, p. 114.

2- Heritage House Roofs Units:

The heritage house consists of a set of rooms oversee the courtyard through the iwans. These rooms are held up by many harmonized octagonal wooden columns. The roofs of iwans are made of wooden parts put in a transverse on top of columns to held the supported wood. Field study and visual observation shows that the heritage house roofs are different in construction from a house to another. Some roofs are made of wood and matting, other are decorated with a set of raws in a geometrical method and centered with diamond shape image (4) .



Image (4) The paved roofs of the Heritage House (Kerkh)

Baghdadi heritage designer of units (rooms) used, on the second floor, the wood for many important reasons such as light weight, which does not impose, pressure on the lower walls and absorbs heat. The guest rooms, usually on first floor, oversee the alley or street. It is proved that the wooden roofs are less in gaining temperature, as shown in table (5).

3-1-9: Primitive Cooling and Heating Systems:

Human used the old cooling and heating methods in the heritage houses units (rooms) to create a comfortable environment in summer and winter . The cooling methods in the summer are - :

1- The basement (vault)

We have already talked about the basement (vault) in climate treatments. It is big in area, built under the units of the heritage house, and the air enter inside through the holes on the narrow path or street or the alley side.

The humidity rises inside the basement from the concrete-free bases and mixes with the air which comes from the external holes. This process creates cold air ventilation that gives a bio-climate to the heritage houses inhabitants in summer. (*field study,2019*).

2- Windows:

These holes are used by the inhabitants of the heritage houses to maintain cool air inside the houses in summer by putting thorns between two layers of palm and but it on windows . He principle is to pour water on them from time to time to create climatic cold air. Villages and rural areas in Iraq* used to use this method.

3- Roofs of heritage houses:

Most of heritage houses inhabitants sleep on the roofs at night in summer. Family of such houses use to spraying water at sunset to create a low heat temperature lesser than heat gained by the surface during the day, especially in july and August. Then the surface becomes cool. The family cover the floor of the roof with cotton and left for a short time To be cool. People in villages and countryside of Baghdad use this method (*Field Study 2019*).

* an interview in Kadhimiyah, 2019, with Mr.Thamir Rasheid Hassan born in 1932.

3-1-10 : Winter heating:

One of the heating methods used by the inhabitants of the heritage houses in Baghdad is a u shape pool made of pottery and decorated with inscriptions with small wooden pieces. Then ignited inside the wood and put a pot of water to spread hot vapor inside the rooms. Family members sit around. This method is used in all Baghdadi heritage houses, the Sumerian period and the marsh areas*.

Fig (3) A pool Filled with wood



Ref: field study

* an interview at 10 a.m on 2nd Jan 2019, with Mr. Hasan Iflayih born in 1930 who lives in Sheikh Ali region, at Alkerkh.

Conclusions:

- 1- The historic centers in Baghdad are considered the real mirror of the Iraqi civilization, its deep historic, and an urban landmark that give us pride and to enjoy and benefit all lesson learned.
- 2- Baghdadi designer used construction materials from the local environment so that it is suitable to face the climate of the region of the study area. Consequently the heritage house should be having a comfortable climate in summer and winter.
- 3-The designer made the basement cooler in summer by the Windcatcher which pull air from the top into a small water pool, inside the basement, to save foodstuff in summer.
- 4-The designer made many functions for the spaces in the heritage house such as the bent corridor, courtyard, roofs, oriel windows, iwans, Windcatcher, basement and the Ursi . All of which give a useful function to the inhabitants.
- 5- Field study shows that the inhabitants of heritage houses used the potted fireplaces and closed doors to increase heat in winter.

Suggestions:

- 1- Conserving the enriched heritage of Baghdad which represents uniqueness of Iraqi civilization spirit. .
- 2-Establishing an Iraqi heritage school which provide cadre in designing and techniques. This specialized cadre must be well trained on periodic maintenance of the heritage environment to conserve the cultural heritage from being destroyed.
- 3-Minimizing the visual pollution of the contemporary architecture placed between heritage houses which lessen the value of the Iraqi architecture.
- 4- Distributing cultural awareness by all means so that to conserve the heritage.

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