Climatic Treatments for Housing in the Traditional Holy Cities: A Comparison between Najaf and Yazd Cities

Ihsan A. JASIM¹, Sabeeh L. FARHAN², Laheab A. AL-MALIKI³, Sohaib K. AL-MAMOORI⁴

¹Department of Architecture Engineering, Faculty of Engineering, Wasit University, Iraq, ihsanabbas@uowasit.edu.iq
²Department of Architecture Engineering, Faculty of Engineering, Wasit University, Iraq, drsabeeh@uowasit.edu.iq
³Department of Hydraulic Engineering Structures, Faculty of Water Resources Engineering, University of Al-Qasim Green, Babylon, Iraq, laheab.almaliki@wrec.uoqasim.edu.iq
⁴Department of Environmental Planning, Faculty of Physical Planning, University of Kufa, Najaf, Iraq, sohaib.almamoori@uokufa.edu.iq

Abstract. The hot, dry environmental conditions prevailing in Al-Najaf and Yazd cities - a modern old problem - must be studied with some detail to come up with new solutions to adapt to the current environmental conditions of the two cities. The research aims to compare the methods used by the residents of Al-Najaf and Yazd cities to handle the hard-environmental conditions in the past and the way to adapt to them. Eight criteria were compared and discussed to investigate the ways and methods to improve the environmental situation in the two cities. The research concluded that there is a great similarity in the environment of the two cities, as well as the environment responding to the treatments that human life adapts. This necessitates the need to preserve the environmental design vocabulary for these two cities (Yazd and Najaf) such as the central courtyard of the aligned residential units to soften the atmosphere within the one unit and increase the family bonding. In addition to preserving the side Shanasheel and local privacy. Yazd city overpass Al-Najaf city by maintaining climate treatments for the historical centre and developing them in line with the development of building methods and construction materials.

1. Introduction

After the development in the relationship between a person and his/her environment, He/she was able to subject many conditions of his/her environment to his/her benefit and comfort. However, the climatic conditions are still strongly affecting our lives, and the issue of adapting it is still impossible in most cases. So, he/she had to adapt to the climatic and environmental conditions of the region. Najaf and Yazd cities are located in a harsh desert environment, but the cities' residents, despite suffering from difficult environmental conditions, have adapted to these conditions and were creative in the means of adaptation. These means improved their environment and livelihood. The harsh environmental conditions are a modern old problem that must be studied in some detail to innovate ways of adapting to the current environmental conditions of the city. The importance of the study emerged from the harsh environmental conditions that the desert cities in the region suffering from, which is general in central and southern Iraq, and in Yazd city. This
phenomenon reflected on people's lives and prompted them to search and think to find ways and means to reduce these conditions affect, and help to adapt to the harsh environment.

The study aims to compare the methods used by residents of Najaf and Yazd cities to address and adapt to the harsh environmental conditions in the past. In addition to finding ways to adapt and improve the environmental situations in the two cities.

2. Methodology

2.1 The Study Area

The study included the historical center of Najaf in Iraq and the historical city of Yazd in Iran.

1- Al-Najaf city:

Najaf is located 165 km southwest of the Iraqi capital Baghdad, 77 km southeast of Karbala and 10 km southwest of Kufa city. It is located geographically on the border between Kufa and the desert. The city has always had problems with water supplies. Its water sources are the Euphrates river and Al-Najaf Sea, which is actually a swamp, and it is located in the southwest of Najaf [1].

Najaf is an old city and most civilizations passed through the Mesopotamia Valley, and Jewish-Christian relics are still prevalent until where there are new discoveries of these relics [2]. Besides, Al-Hirah city, which, was the largest Christian center in Iraq, is located near Al-Najaf city. However, it flourished after the burial of Imam Ali and the construction of his shrine in it, where it began to expand as a result of the migration of some Islamic groups and visitors flocked to the shrine. Consequently, many buildings assembled around it, and civil and religious architecture pursued [3].

The old city is currently suffering from tremendous pressure due to a set of urgent requests for the city to be a destination for visitors. In addition to the Holy Shrine of Imam Ali, there are a number of mosques, libraries, and religious schools throughout the city. Also, there are a good number of empty spaces all over the city [4].

![Figure 1. Najaf city location map](image)

2- Yazd city

This governorate in Iran is considered a desert province, and the deserts occupy a large area in it. It is characterized by a hot and dry summer due to the lack of rain in the winter. Yazd is located on the central part of the Iranian plateau 670 km from Tehran and it is the capital of Yazd Province that located on the border with the southern provinces of Khorasan, Isfahan, Fares and Kerman. Being located near the central mountains away from the Caspian Sea and the gulf, and also due to the proximity of two major deserts on the Iranian little rain plateau, Yazd climate is mostly similar to the
arid and semi-arid regions of the desert[4]. Hot weather, low humidity with little rainfall and a high degree of evaporation are the main factors that make Yazd Province one of the drier provinces of Iran, bringing the temperature to 50 degrees Celsius in the summer, and in the winter to reach a severe cold of 20 degrees Celsius below zero [5]. Sandy winds often blow in the spring and autumn, as sand covers intercity roads. The city has a long history of 3000 years, dating back to the time of the Median Empire, and is one of the oldest settlement areas in Iran. It has been preserved throughout history because of the harsh nature surrounding it and its distance from important capitals. This site provided the city with a natural defensive position and avoided destruction due to wars. Therefore, many of its traditions and examples of its cities and architecture remain until recent times [6].

Figure 2. Yazd City Location Map.

2.2 Environmental and designing criteria

1- Interior Courtyard
Najaf City:
Najaf buildings are distinguished by the interior courtyard. It is the internal space of the residence that linked to the outer space on the one hand, and to the other internal spaces on the other hand, which gives a feeling of relief. The purpose of this yard is to ease air movement and circulation in the building and with the presence of the fountain, the air will be fresh and cool. This strategy helps to improve the climatic environment for this part of the residence.

Yazd City:
The interior courtyard is the focal point and one of the best cooling places of residences in Yazd. Most residence has an interior courtyard that provides protection from the sun and sandstorms. Sharing this function with the high walls around the courtyard in all areas. In addition to a large water pool in the middle to provide shading and reduces air temperature during hot days by evaporative cooling and convection systems, hot air passes into the pool in the yard and reduces temperature by evaporative cooling, so the cold air created in the yard removes the hot air by convection systems. These walls also provide privacy for its users, by opening windows facing the courtyard, and take advantage of natural ventilation and cooling [4].
The wind catcher (wind-tower)

In hot dry areas, a climatic limit should be ensured to the human being's comfort, that is, the temperature within 18-25 °C and relative humidity of 30-60%. The main element in securing a suitable limit for climate inside the residential units is ensuring effective ventilation. Therefore, the windcatcher is one of the most important means to achieve ventilation inside the residence if directed in the right direction (i.e., the northwestern side).

Najaf City:

The windcatcher is a tunnel that passes through thick walls of the residence and ends at the roof of the residence with its upper openings are directed towards the north or northwest, where the source of the prevailing wind [8]. Its function is to bring cold wind into the residence and works to deliver fresh air to the rooms and basement, creating cool ventilation and a mild climate without windows [9].

Yazd City:

In Yazd city, the windcatcher is one of the most unique design elements. Its height ranges between 2 - 22m and some designs may reach 31m. It works the same way as mentioned in Najaf city and contributes to cooling the residence together with a small pool of water in the basement.
The windcatchers were widely used in old residences, where they reduce the temperature around twenty degrees lower than the courtyard, especially in the summer. Yazd city residents still use the small pond basement and fountain to escape the hot weather during the summer. In the past, the basement was also used as a natural fridge to store and preserve foods such as fruits and meat for several days. Because of the coolness provided by the windcatcher (see Fig. 9).

The world's longest windcatcher is located in the Dolat Abad Grove, where this air catcher is 33 meters high. It is characterized by its eight sides, which facilitates the rapid movement of air and directs it to its lower section to touch the water surface of the small pond located below it, in preparation for providing cold air inside.

![Figure 5. The Windcatcher in Yazd City (The Researcher).](image1)

3- The Basement

Najaf City:
The basement is a room below the ground floor that is used as a place to spend naps on hot summer days, and sometimes it is used as a food store in winter. In addition to its functional advantages, it has architectural advantages, as it uses bricks in its construction in a skilled way in the roofing process, which gives a vivid picture of the architecture in dealing with environmental conditions. Usually, most residences in Najaf had one basement and sometimes two basements.

![Figure 6. The Basement in Najaf City](image2)
Yazd City:

In Yazd, the residences have more than one underground room to preserve foods and protect residents from sunlight during the summer. In some traditional buildings, there is a small pond under the ground that is connected to the groundwater network. Therefore, the subsoil with a swimming pool in the middle of the basement connected to the water networks that create a comfortable indoor temperature for residents, especially during hot days where they can escape from the warm open air in Yazd. The thickness of the basement roofs rises approximately 70 cm above the courtyard. Windows are located between the courtyard and the basement, which are dedicated to natural daylight and ventilation. The height of the basement roof in traditional residences increases by approximately 2.5 meters. However, faceted small windows on the top of the basement walls in the spaces that create natural ventilation and daylight. This process also provides light and ventilation to both food and its passengers during hot days.

The basements in Yazd city are very widely spread, and sometimes they are two floors under the ground, as there is another type of underground basements its function is to collect or store water and preserve it for the short period in the summer.

4- Urban architecture orientation

Najaf City:

The alleys in Najaf city are characterized by their narrowness and meandering to reduce the sunlight effect by preventing its access to the alley floor, in addition, to facilitate the air currents moving. It also contributes to reducing wind speed and getting rid of dust and dirt. The capacity of alleys varies from one region to another. In some neighborhoods, the width may reach two meters so that it only allows one or two-person and one of the animals to pass.

Yazd City:

The concentration of urban fabric reduces the penetration of dusty winds into the residential units. The covered walkways and narrow alleys with long mud walls provide shade and comfort in the hot summer. Moreover, the direction of the wall is a way to avoid the hot summer sunlight and high winds.
The front side of the residence faces the south to get rid of sunlight (which is warmer in summer and cooler in winter). Also, the walls that built to face the east-west are cool in winter and warm in summer more than southeast and southwest. Accordingly, the courtyard is planned towards the north-south direction to achieve the minimum east and west exposure to sunlight in summer and the maximum amount of sunlight in the winter season [10]. Also, the alleys are characterized by the presence of domes and arches. The domes provide shading for the pedestrians as well as the arches that can carry a load of the brick walls in front of each other. The lack of windows on the walls that facing the alleys is another reason that helps increases the presence of these beautiful elements with various heights.

![Figure 8. Urban Architecture Elements: A:Najaf city, B: Yazd City](image)

5- Waterbodies
Najaf City:

The Waterbodies mean the water fountain or bond inside the courtyard, which helps to cool the air in the interior courtyard and raise the relative humidity in the air. It also helps to move the air inside the residential unit and contributes to alleviating the climatic conditions in the traditional Arabian residence [11].

Yazd City:

The main rooms in the residence face southwest and southeast directing, the window openings in the walls are directed within 15-45 degrees to the west of the south to give the optimal results. The courtyard, where plants and trees are formed is compatible with the desert environment together with the water pond, make the climate comfortable in this hot region [6]. The air released by the windcatcher runs in the interior spaces and on the surface of the water in the middle of the courtyard and plants get enough cool in the afternoon. Arranging the residence spaces helps to maximize the use of this renewable energy.

6- Construction materials
Najaf City:

Various construction materials were used that suit the natural environment of the city. Usually, local bricks were used as the base material for building the ground floor, and pottery may be used in construction sometimes [12]. Wood is also used as an important building material, especially in
the installation of the shed and balcony. Wooden grids are used at the end of some balconies to provide family isolation. Perforated wood is also used in bedrooms that are not facing the alley, while the rooms overlooking the street use sliding wooden windows [13].

Yazd City:

The city's texture unit is strengthened by using clay and clay bricks as local major building materials, which contribute to reducing heat absorption and also reflect sunlight. These materials, as well as thick walls, are the current solution to insulate the building against temperature changes. Aggregates also used to fill the space between walls and ceilings. These materials are sustainable because they are close to the construction site and do not involve energy and transportation costs. Moreover, the building decomposes naturally and without pollution, and returns to the ground again, and this can be considered as a measure of sustainable development [6].

7- Dealing with the facade of the building

Najaf City:
The walls of the rooms overlooking the alley consist of architectural formations and sliding wooden windows of high decoration called Shanasheel. Al-Shanasheel has developed as a social necessity to prevent mutual overlooking of the opposite houses. Moreover, it is of environmental necessity as it reduces sunlight in the alleys its influence into the house, especially the upper floor rooms[14]. The prominent part of Al-Shanasheel from the first floor on the ground floor level in many traditional buildings is considered an additional space, which is a distinctive feature in the historical neighborhoods that are located in the old city because it provides additional shade. In some places, this prominent part rise corresponds to another one on the opposite side of the alley to make a Tunnel-like passage [15]. Numerous attempts have been made to make such prominent protrusions in modern buildings using metal panels. Therefore, such use should be encouraged in the design of traditional buildings in historical neighborhoods, avoiding conflict between adjoining buildings. Wooden panels should be used in the construction of heritage buildings [16].

Yazd City:
Sun-dried or fire- dried clay bricks are the main building materials used in Yazd city. These materials are locally available and good for reflecting sunlight for being light-colored materials. The bricks are made of a mixture of clay, water, and straw, grass, or hair from cattle, which increase the adhesion of mud, by acting as a bond material and removes cracks, which improves heat resistance [10].

![Figure 9. building facade A: Najaf city, B: Yazd City.](image)
8- **Iwans**

**Najaf City:**
Iwan is an important planning element on the ground floor of the Arabian residence. It is usually rectangular in shape, completely open towards the yard, takes a good location in the residence, and is surrounded by other rooms[17]. The Iwan usually faces the direction of the sun and used in the summer as a dining room and a place to drink tea or a place to take naps. There might be one for the summer and another for the winter. The iwan usually rises (20 - 30) cm above the level of the yard, which provides psychological relief for the residents of the residence [18].

**Yazd City:**
There is an iwan between the summer rooms and the patio in all the homes. However, in Yazd Homes there is a large semi-open gap next to the summer rooms. The summer parts of the two are different in shape but have the same functions that protect from sunlight and provide cool ventilation to the residents.

### 3. Adoption and Development of Climatic Treatments

Yazd city has the advantage of preserving its urban fabric within its historical center. Any buildings that contradict the prevailing fabric and not compatible with it are not allowed to be constructed. In addition, there are many recent applied types of research on the use of the treatments referred to in this study in modern architecture. Thus, Yazd city has surpassed the city of Najaf, which lacks these procedures.

### 4. Conclusions

1- There are great similarities between Najaf and Yazd cities in many ways. The two cities are considered one of the important Islamic cities that contain a great cultural heritage in terms of mosques and shrines. Also, the two cities are considered to be historical cities, although Yazd dates back to an earlier history. The resemblance extends to the environment as both cities are considered desert cities. However, the conditions of Yazd city are more severe due to the large variation in temperature between summer and winter and the leak of water, which led to the establishment of channels to provide water for the city.

2- The two cities (Najaf and Yazd) were distinguished by extraordinary climatic treatments in the residence, neighborhood, and the whole city, such as Al-Shanasheel, the wind catchers, the basement, the central courtyard, and other treatments. Therefore, there is a need to preserve the environmental design vocabulary of these two cities like the central courtyard of the compacted residential buildings and the air purifier (windcatcher) to soften the atmosphere within the residence and increase the family bonding. Also, the narrow winding alleys in the residential neighborhood to protect from strangers and reduce the impact of wind laden with dust and dust. Maintain the Shanasheel with its beautiful decoration and local character.

3- Through the field visit, it is clear that the historic area in Yazd city has been preserved and its identity was conserved by removing and preventing any violations. While Najaf city lacks these measures and regulations. Therefore, it is essential to benefit from the experience of Yazd city in preserving the traditional environmental treatments that constitute the identity of the city. And re-employ those solutions used in line with the historical role of Najaf city.

### References

[1] Farhan, Sabeeh Lafta, Jasim, Ihsan Abbas and Al-Mamoori, Sohaib Kareem, 2019, The transformation of the city of Najaf, Iraq: Analysis, reality and future prospects. *Journal of Urban Regeneration and Renewal, Volume 13*, Issue 2.
[2] Farhan, S.L., I.A. Jasim, and A. Naji, 2016, Urban sustainability in Old City Centres, a Comparison Between the City of Najaf in Iraq and Italian Cities Experiences. *Engineering and Technology Journal*, 34, 12, 2347-2360.

[3] Sabeeh Lafta Farhan, Mohamed Gamal Abdelmonem, and Zuhair A. Nasar, 2018, "The Urban Transformation of Traditional City Centres: Holy Karbala as a Case Study." *Archnet-IJAR: International Journal of Architectural Research. Vol. 12*, issue 3, 53-67.

[4] Zarabadi, S. and N. Karimi, ACHIEVEMENT TO URBAN SUSTAINABLE FORM.

[5] Abouei, R. Conservation of Badgirs and Qanats in Yazd, Central Iran, 2006, in The 23th conference en passive and low Energy Architecture, Geneve, Switzerland.

[6] Monshizade, A. The desert city as an ancient living example of ecocity. 2008.

[7] Abdul Sahib Naji Al-Baghdady and K.a. Haider Abdul –Raziq, Ways to maintain the identity of the contemporary Arabic city from the phenomenon of globalization 2010, *Al-Kufa Literature journal. 1*(6), p. 21-53.

[8] Salkini, M.A., *Environmental Architecture*. 1999, Gabes House for Printing, Publishing and Distribution.

[9] K., H.A. and B.R. Sh., Architectural Transformations in Holy Cities Center 2009, “ The holy city of Najaf as model ” *Journal of Engineering*. 15(4), 764-784.

[10] Mashhadi, M.K., *Comparison of Iranian and Turkish TraditionalArchitectures in Hot-Dry Climates*. 2012, Eastern Mediterranean University (EMU).

[11] DawoodJasim Al-Rubaei, A.S.N. Al-Baghdadi, and Z.A.R.A.H. Altglbe, 2015, Geographical Analysis of Air Pollution inAl-Najaf Governorate, *Adab Al-Kufa*. 1(22), 85-120.

[12] K.,H.A. and A.-s.N. A., The relationship between environment, security and development 2010, *The islamic college university journal*, (12); p. 9-37.

[13] Jassim, I.A. and M.A. Jalil, The emergence and development of the neighborhood idea and its relationship to the local Iraqi environment 2016, *Engineering and Technology Journal* 34(10 Part (A) Engineering); p. 434-450.

[14] Mashhadi, M.K., *Comparison of Iranian and Turkish TraditionalArchitectures in Hot-Dry Climates*. 2012, Eastern Mediterranean University (EMU).

[15] Farhan, S et al., 2020, Analysing the Development Master Plan & Urban Heritage of the Holy City of Najaf, Iraq.

[16] Farhan, S.L., I.A. Jasim, and A. Naji, Urban sustainability in Old City Centres, a Comparison Between the City of Najaf in Iraq and Italian Cities Experiences, 2016, *Engineering and Technology Journal, 34*(12), 2347-2360.

[17] Farhan, S et al., 2020, Conservation of the Historical Centre of Al-Najaf City based on British Examples, *Journal of Cultural Heritage Management and Sustainable Development*.

[18] Sabeeh Farhan, Mohamed Gamal Abdelmonem, 2018,NAVIGATING THE SOCIO-SPATIAL AND PLANNING CONDITIONS OF TRADITIONAL PUBLIC SPACES IN IRAQ’S HOLY CITIES, Traditional Dwellings and Settlements Review. international Association for the Study of Traditional Environments (IASTE), *Vol 30*.

[19] Farhan, S et al., The transformation of the inherited historical urban and architectural characteristics of Al Najaf’s Old City and possible preservation insights, Frontiers of Architectural Research, https://doi.org/10.1016/j.foor.2020.07.005