CLIMATE ADAPTED HOUSES IN IRAN: HOT, COLD AND HUMID CLIMATE

UDC 72:551.583(55)

Mahtab Baghaiepoor¹, Goran Jovanovic², Mirko Stanimirovic²

¹ Iran University of Science and Technology, School of Architecture and Environmental Design, Iran
² University of Niš, Faculty of Civil Engineering and Architecture, Niš, Serbia

Abstract. The issue of Climate Change has raised so much attention for decades, specifically in recent years. Modern trends in urban architecture which tried to create living machines similar to each other in any context, have now been proven to be insufficient and unless we decide to respect nature and make our buildings cooperate with their contexts as soon as possible we cannot address further threads regarding our future life. If we take a look at traditional architecture existing in old towns and rural area, we can see how people managed to bond a new construction with its surroundings. In this article we study different architectural patterns which exists in old architectures of towns and villages in Iran; the country which can be a good case study due to its rich diversity of nature, climate zones and architectural background. In Iran we have a range of climate of cities from hot and dry to humid and very cold ones. So, depending on the city climate, water supplies and energy sufficiency people tried to create best residential buildings. Here we try to check out some examples.

Key words: Iran, climate change, houses, architecture

1. INTRODUCTION

The issue of Climate Change has raised so much attention for decades, specifically in recent years. We can now see and feel how everyday life is being affected by the consequences of this global concern and the urge of taking the knowledge into action needs to be addressed more than ever. While more than half of the world population live in cities, Urban Architecture seems to play a significant role in energy usage and sustainability. The way that our buildings respond and bond with their nature can have a crucial impact on energy sufficiency. Modern trends in urban architecture which tried to create living machines similar to each other in any context, have now been proven to be
insufficient and unless we decide to respect nature and make our buildings cooperate with their contexts as soon as possible we cannot address further threads regarding our future life. If we take a look at traditional architecture existing in old towns and rural area, we can see how people managed to bond a new construction with its surroundings.

![Iran Climate Zones](https://fanack.com/iran/geography)

**Fig. 1** Iran Climate Zones (Iran Geography, n.d. Archive of Fanack)

In this article we study different architectural patterns which exist in old architectures of towns and villages in Iran; the country which can be a good case study due to its rich diversity of nature, climate zones and architectural background. In Iran we have a range of city climates from hot and dry to humid and very cold ones which are shown in the figure below (Fig.1). So, depending on the city climate, water supplies and energy sufficiency, people tried to create best residential buildings. Here we try to check out some examples. To better study the subject, four major climates zones now existing in Iran are classified into ‘Hot and Dry’ climate, ‘Hot and Humid’ climate, ‘Cold and Very Cold’ climate and ‘Moderate and Humid’ climate. We study the main characteristics of each climate zone and then we mention architectural ideas which helped the building collaborate best with its settings.

The method of research in work is adjusted to the nature of the research, which requires the application of several methods. The methods used here are: analysis, synthesis, comparative method.

---

1. https://fanack.com/iran/geography/
2. HOT AND DRY CLIMATE

In this climate we have

- Burning sun
- Very high temperature in day in very low temperature at night
- Hot summers and Cold winters
- Dry weather, little raining and lack of water
- Sand and dust thunders

Cities like Yazd, Kerman, Shiraz and Kashan which are mainly located in the middle of Iran comprise this category (Hassan, 2015, 3).

The most important building characteristics are ordered into:

2.1. Orientation

![Fig. 2 Winds Orientation in Center of Iran (Source: Hassan, 2015)](image)

Building the house in Northeast-Southwest Orientation to receive cool summer breeze and reject cold wind. (Fig.2)

2.2. Compactness

Houses are dense and have joint walls. Alleys are narrow and curved so that unwanted winds cannot easily enter the house and this characteristic also helped defending the city in old times.

These curved paths also provide more shadow for pedestrians. (Fig.3)
2.3. Materials

Using materials which is accessible around the city and has a high heat capacity is very important. The combination of soil and water creates a perfect match! So “clay” and “Mudbrick” are the main materials to build the houses. Not only have they got a high heat capacity but also their bright color helps the building to absorb less heat in summer and reveal less heat in winter. Also people try to use bright colored coverings on the wall; Things like Plaster. (Fig.4)

Fig. 3 Bird View of Yazd, Iran (Source: Archive of Kayhanlife³)

Fig. 4 Brick and Mudbrick as the Main Materials (Source: Archive of Kayhanlife)

³ https://kayhanlife.com/unesco-inscribes-iranian-city-yazd-world-heritage-list/
2.4. Form of the Building

In order to reduce the outside openings and preserve the inside space from sand storms the shortest side of the building would be facing the wind. Overall the cubic form is the best matching form. Walls are thick, ceilings are high and openings are mainly inside the house, facing the main central yard. So, the houses built in this climate are mostly introspective. (Fig.5)

![Fig. 5 Introspective Housing, Yazd, Iran (Source: Archive of Kayhanlife)](image)

2.5. Down-level Central Courtyards

The courtyard is built in the middle of central yard and is usually deeper than the whole building so it can be at lower temperature. Courtyards are usually including a big fountain and some trees to reduce the temperature on a whole of 3-4 degrees. (Sadat, 2013) (Fig.6)

![Fig. 6 Down-level Garden in a House in Yazd, Iran Đokuseland (Source: Archive of Kayhanlife)](image)
2.6. Wind Catchers

Wind tower (wind catcher) is a traditional Persian architectural element to create natural ventilation in buildings. Windcatchers tend to have one, four, or eight openings. In the city of Yazd, all windcatchers are four- or eight-sided. The construction of a windcatcher depends on the direction of airflow at that specific location: if the wind tends to blow from only one side, it is built with only one downwind opening. This is the style most commonly seen in Meybod, 50 kilometers from Yazd: the windcatchers are short and have a single opening.

Depending on the direction and type of wind, windcatchers are designed in many different types and if there is a small fountain under them, they can create a very cool atmosphere underneath. To keep buildings free of dust and sand blown in from the desert, windcatchers were built facing away from the wind. (Hengameh, 2013) (Fig. 7, 8, 9, 10)

![Wind Tower Diagram]

**Fig. 7 Wind Catcher Functionality** (Source: Archive of Goumbook)

1 http://goumbook.com/wind-tower-traditional-zero-energy-cooling-system/
Climate Adapted Houses in Iran: Hot, Cold and Humid Climate

Fig. 8 Dowlat Abad Garden and Wind Catcher, Yazd, Iran
(Source: Archive of Chasingtheunexpected⁴)

Fig. 9 Fountain under Dowlat Abad Wind Catcher, Yazd, Iran
(Source: Archive of Chasingtheunexpected)

⁴ https://www.chasingtheunexpected.com/beneath-yazd-tallest-wind-catcher-beautiful-dolat-abad-garden/
So here is a complete example of House featured above:

![Diagram of Lari’s House in Yazd, Iran](image)

**Fig. 10** Lari’s House in Yazd, Iran (Hassan et al, 2015)

### 3. HOT AND HUMID CLIMATE

A thin line of cities near the Persian Gulf in south of Iran like Bushehr and Bandar Abbas are in this climate. In this Climate we have:

- Low annual rain
- Very High humidity throughout the year
- Very Hot weather in summer and moderate in winter
- Little temperature fluctuation in day and night
- Poor vegetation (Shahryiar, 2008)

The most important building characteristics are ordered into:

#### 3.1. Semi-Introspective buildings with central courtyards

They also connect to the outside of the house in reverse to hot climate buildings:

#### 3.2. Very high ceiling and windows

The height of windows sometimes reaches 4 meters. Hot air would climb up and get out of the room through the windows below the ceiling (Fig. 11).
Climate Adapted Houses in Iran: Hot, Cold and Humid Climate

3.3. Wide and high Balcony (Shenashil)

Balconies are important part of the house, because when it is hot and humid there is better shadow and ventilation there and most of time of residents is spent in Shenashils.

3.4. No underground construction

Because of the sea level they cannot have underground constructions, so the ground level is important for storage of food and the rooms are in first and second level to receive better ventilation.

3.5. Flattened ceilings

No curved or round ceiling is common here. So people can sleep on the roof at nights.

3.6. Materials

Here also people use materials with high capacity of heath and bright colors such as white plaster and brick. Wood is also used for windows (Mohammad, 2015, 10). (Fig.12)
4. COLD AND VERY COLD CLIMATE

Cities Located in west of Iran, Mostly around the Zagros Mountains Like Sanandaj, Kermanshah and Tabriz. (Fig.13,14) In this Climate we have:

- Long-lasting cold winters
- Short cool summers
- Downfalls mostly in Snow
- Significant temperature Fluctuation in day and night
- Low Humidity (Majid, 2010)

The most important building characteristics are ordered into:

- Orientation and Compactness in Plans (trying to receive the most winter sun and the least winter wind)
- Least surface/volume ratio (cubic form of Plans)
- Introspective buildings with central yards
- High heath capacity materials (they use stones and wood to build a house and where possible they use clay)
- Low height ceiling
- Flattened roofs (to use snow as an insulation)
- Small openings and gardens (because of the cold weather most of residents’ time is spent indoor. They use windows to trap sun in the room and warm it) and
- Thick walls (Mohammad, 2015)

Fig. 13 Houses in Cold Climate, Palangan, Kurdistan, Iran (Source: Author’s collection)
5. **MODERATE AND HUMID CLIMATE**

A thin line of cities near the Caspian Sea in North of Iran - from east to west - are in this climate. In this area the short distance between Sea and Alborz Mountains caused the weather to be always humid. Cities such as Mazandaran, Golestan and Guilan are in this climate zone. In this Climate we have:

- Warm and Humid Summers and Moderate Winters
- High rain level and Humidity
- Low temperature fluctuation in day and night (Yusuf, 2000)

The most important building characteristics are ordered into:

- Orientation (generally east-west stretched House plans)
- Openings (in all sides of the house there are high openings)
- No underground constructions (because of the humid level ground houses are mostly built on a wooden foundation)
- Materials (low heath capacity materials such as wood, cement, stones and rice shoots are used)
- Gable roof (buildings closer to the sea have higher ceiling and sharper Gable roofs)
- Extrovert Houses and Ivans (Ivans are of the most importance. Humidity causes the residents to spend most of their time out of buildings and so Ivans can provide both wind and a shelter to the rain) (Fig.15)
Wind ventilation (the most important feature is to provide wind circulation in the house with proper positioning of the windows) (Mohammad, 2015). (Fig.16)
So, here is a complete example of House featured above (Fig. 17, 18):

Fig. 17 A Northern House Functionality (Source: Author’s collection)

Fig. 18 Rafiee’s House, Guilan, Iran (Source: Archive of Guilan Rural Heritage Museum\(^5\))

\(^5\) http://www.gecomuseum.com/LandingPage.aspx
6. COMPARATIVE ANALYSIS

The following table presents (Tab.1) a comparative analysis of the examples presented in four climate systems in Iran.

### Table 1 Features of Residential Architecture in four main climates of Iran

| Climate                        | Hot And Dry | Hot and Humid | Cold and Very Cold | Moderate and Humid |
|-------------------------------|-------------|---------------|--------------------|--------------------|
| Annual Rain                   | Very Low    | Low Annual Rain | Mostly Snow | High               |
| Day/Night Temperature fluctuation | Significant | Little Fluctuation | Significant | Little             |
| Humidity                      | Dry         | High Humidity  | Fluctuation | Low Humidity | High Humidity |
| Summer/Winter Intensity       | Hot Summer  | Hot Summer    | Cool Summer | Warm Summer | Very Cold Winter |
|                               | Cold Winter | Moderate Winter | Very Cold Winter | Moderate | Winter |
| Other Features                | Sand and Dust | Poor Vegetation | - | East-West |
| Plan orientation              | Northeast-Southwest | East-West | Northwest-Southwest | East-West |
| City Fabric                   | Cubic Dense | Intensive and Continuous | Cubic Dense Fabric | Linear stretched Fabric |
| Material                      | Clay Mudbrick | White plaster | Stone | Stone |
|                               | Brick       | Wood          | Wood | Wood |
|                               |             |               | Clay (if available) | Cement | Rice Shoots |
| Introspective/extrovert       | Introspective | Semi-introspective | Introspective | Extrovert |
| Architecture                  | Down-level Courtyards | Central Yards Shenashis (Balcony) | Low height ceiling | Numerous Openings |
| Windcatchers                  | Flattened Roofs | High Ceiling Thick Walls | Flattened Roofs | No Underground Construction |
|                               |             |               |               | | Gable roofs |

(Source: Author)

7. CONCLUSION

In this paper four main different types of climate in Iran have been studied. As shown in the table below, we can see that in the middle of the country dry weather (Cold/Hot) has resulted into introspective houses in Northeast-Southwest Floor Plans with denser city fabric; while by approaching north and south we have more humidity in result of Caspian Sea and Persian Gulf and therefore houses tend to look outward with East-West Floor Plans to receive the best wind and city fabric becomes more spread.
Overall the use of local material is a key element in old Persian Architecture and it is depicted how buildings have been adapted to the nature and people built their houses with complete respect and collaboration with their surroundings, coming up with specific ideas for different climates, feature that we highly lack in today’s architecture specially in regards to the recent climate change issues.

REFERENCES

1. S. Hassan, A.B. Fatemeh, C. F. Sadat. “Climate Oriented Design Solutions in the Architecture of Old Buildings in Yazd” in National Conference on Civil and Architectural Approaches to Sustainable Development, 2015, Conference Proceedings.
2. P. Mohammad, R. Vahid. “The Impact of Climate Factors on Building Design and Sustainability” in National Conference on Civil and Architectural Approaches to Sustainable Development, 2015, Conference Proceedings.
3. H. F. E. Sadat, R. Parisa. “Solutions for Sustainable Design in Hot and Dry Climate, Case Study: City of Yazd” in National Conference on Architecture, Urban Development and Sustainable Development with a focus from native architecture to sustainable cities, 2013, Conference Proceedings.
4. S. Hengameh, R. Ali, R. Javad. “Impact of Water on Architectural Sustainability of Buildings in Hot and Dry Climate” in National Conference on Architecture, Urban Development and Sustainable Development with a focus from native architecture to sustainable cities, 2013, Conference Proceedings.
5. S. Majid, K. Mahnaz. “A Study of Traditional Architecture Compatible with Cold Climate: case study: City of Sanandaj” in Geographic Quarterly Records No 10, 2010, pp 91-115.
6. G. M. Yusuf, D. Kimia. “Impacts of Climate on the Formation of Guilan Traditional Architecture Elements” in Armanshahr Architecture and Urbanism Journal No 4, 2000, pp 12.
7. M. Shahriyar. “Sustainable Building Design Based on Hot and Humid Climate” in Hoviate Shahr Journal No 5, 2008, pp 39-46.

KUĆE U IRANU PRILAGOĐENE KLIMI: TOPLA, HLADNA I VLAŽNA KLIMA

Pitanje klimatskih promena je izazvalo puno pažnje, posebno u poslednjih deset godina. Savremen trendovi u arhitekturi i urbanizmu koji su pokušavali da stvore žive mašine slične jedna drugoj u bilo kom kontekstu, sada su se pokazale nedovoljnim. Ukoliko se ne odlučimo da poštujemo prirodu i učinimo da naše zgrade budu u skladu sa svojim kontekstim, ne možemo se baviti daljnjim životnim temama. Ako pogledamo tradicionalnu arhitekturu koja postoji u starih gradovima i ruralnim područjima, možemo videti kako su ljudi uspjeli povezati novu građevinu s okolinom. U ovom članku proučavamo različite arhitektonске obrasce koje postoje u starim arhitekturama gradova i sela u Iranu, u zemlji koja može biti dobra studija slučaja zbog svoje bogate raznolikosti prirode, klimatskih zona i arhitektonске pozadine.

U Iranu postoje, u pogledu klime, različiti granovi: topli, suvi, vlažni i veoma hladni. Zavisno od gradske klime, vodosnabdevanja i dovoljne energije, ljudi su pokušali da naprave najbolje kuće za stanovanje. U ovom radu su analizirani neki od karakterističnih primera.

Ključne reči: Iran, klima, kuća, arhitekturna