SUSTAINABLE BUILT HERITAGE

LANDSCAPE ANALYSIS SUPPORTED BY GIS TOOLS

YAZD, IRAN

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Sustainable Built Heritage
Landscape Analysis Supported by GIS Tools
Yazd, Iran

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Abstract

This study explores the impact of sustainable architecture in Iran and analyzes the conventional construction methods utilized by local communities. Taking into account the country's varying climate, which experiences four distinct seasons, the research evaluates the use of local materials and resources, which are readily available due to Iran's abundant mines.

A Geographic Information System (GIS) analysis was carried out to assess various aspects of the country, such as elevation, climate, and land use patterns. The study focused on a particular region to demonstrate the practical application of the GIS analysis and how it can be utilized to promote sustainable building practices.

In addition to the GIS analysis, the study also included on-site research and experiments in different cities to assess the climate and its impact on sustainable architecture. Based on the findings, the research concludes with recommendations for appropriate building techniques and materials, tailored to each specific region, to encourage the construction of environmentally friendly buildings in Iran. This study provides a comprehensive insight into the potential of sustainable architecture in Iran, taking into account both the GIS analysis and on-site research and experiments.

Thesis objectives and aims

Aim: To determine the most appropriate materials and construction techniques for building environmentally friendly structures in different climates and evaluate the impact of these strategies on cost and energy efficiency.

Objectives:

To identify the most suitable materials for building in different climates based on their availability and cost-effectiveness.

To determine how low-cost construction techniques can be utilized to achieve high energy efficiency.

To analyze the strategies used for constructing buildings in various climates and determine the most effective methods.

To modernize the information obtained from each climate by utilizing the latest technologies and methods.

To examine the various components of building structures, including tactics, materials, finances, and cultural considerations, to identify opportunities for improvement.

Problem statement: Research questions

1- What materials must we utilize for each climate?

2- How can a low-cost construction achieve high energy efficiency?

3- What were the strategies for constructing in a distinct climate?

4- How can we modernize all of the information we get from each climate?

5- Examine every component of the structure, including tactics, materials, finances, and culture.

Methodology

This research study aimed to explore sustainable architecture in Iran and was based on three primary approaches: on-site visits, a comprehensive review of related literature supported also by insights from Iranian architecture professors, and landscape analysis based on GIS tools.
Over a period of three months, I traveled across different regions in Iran, experiencing the varying and extreme climatic conditions in each place. The journey began in the Mediterranean region, which experiences rainfall almost every day, followed by the eastern region, where temperatures drop below -5°C. The south region was characterized by extreme heat and humidity, with temperatures reaching up to 38°C and humidity levels surpassing 70%. The final destination was the city of Yazd, located in the central part of Iran, with a hot and dry climate.

During my visits, I stayed in sustainable houses in each city and had discussions with local residents and the Department of Cultural Heritage to gain insights into sustainable architecture in that region. The consultation meeting with two architecture professors, prof. Mohesn Tajik and prof. Leila Mousavi, from my undergraduate studies helped me to better understand the topic and provided me with several recommended textbooks and articles to review. A thorough bibliography research, combined with a review of related videos, allowed me to expand my knowledge on the topic of Iranian heritage sustainable architecture.

Lastly, I conducted a holistic GIS analysis of Iran and a regional analysis of the city of Yazd to better comprehend the factors such as climate, elevation, and their impact on sustainable architecture.

Based on the analysis and research, I was able to recommend efficient alternatives for sustainable buildings in Iran.

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Introduction

Iran, a large country with diverse climates, has a rich history of building structures that provide comfort and promote environmental sustainability. In the past, traditional builders in Iran constructed various types of buildings, including homes, religious institutions, commercial centers, schools, and service facilities, in the different climate zones of the country. The four climate zones in Iran range from regions with heavy rainfall and high humidity to areas with extremely dry and cold winters. In the absence of modern technologies, traditional builders in Iran relied on natural resources such as soil, stone, sand, water, and plants, and harnessed the power of the sun and wind to build structures that were able to withstand the harsh weather conditions. In contrast, modern construction methods are focused on maximizing resource consumption while minimizing waste and pollution. Despite the use of advanced construction materials and tools, modern buildings are often expensive to build and maintain, and they generate a large amount of waste and pollution. In contrast, traditional builders had to carefully study the environmental conditions and make the most of the limited resources available to them. For example, in the past, people in the capital city of Tehran used to sleep on their rooftops on hot summer nights and stay in their cool basements during the day to escape the heat. They also used natural methods such as watering plants and spraying water to cool the air, and used straw canopies to shield themselves from the summer sun. Today, the cost of maintaining mechanical equipment and the growing concerns about environmental pollution are leading to a renewed interest in clean and renewable energy sources such as solar, wind, geothermal, biogas, and hydroelectric energy. With Iran's vast deposits of oil and natural gas, it is essential to find alternative sources of energy to ensure a sustainable future for the country and its environment. While it may not be possible to completely return to the ways of the past, studying the methods used by traditional builders and their understanding of the environment can provide valuable insights into creating sustainable and environmentally friendly structures. By repairing the connection between humanity and nature, we can maintain clean and green environments, preserve natural spaces, and limit the extraction of fossil fuels. An ancient Persian saying, "there is sense in experience," highlights the wisdom that can be gained from the experiences of our ancestors, and we can find sense and reason in many of the ideas and methods used by traditional builders in Iran.

CHAPTER 1

CLIMATIC FACTORS

The adaptation of their physical shape to their natural location and climatic circumstances is an essential component of almost all traditional structures in Iran. This is obvious in all of Iran's structures from various climatic zones. The climate of each location has a direct impact on the urban fabric, building shape, and construction materials of these regions. The climatic state of any area is determined by its geographic position on the earth's surface. Latitude, height, and distance from the sea or ocean are the geographic factors that influence the climatic conditions of any place. These three are known as climatic factors, because they influence the quantity of solar radiation, temperature, precipitation, humidity, and wind strength and direction in some manner.

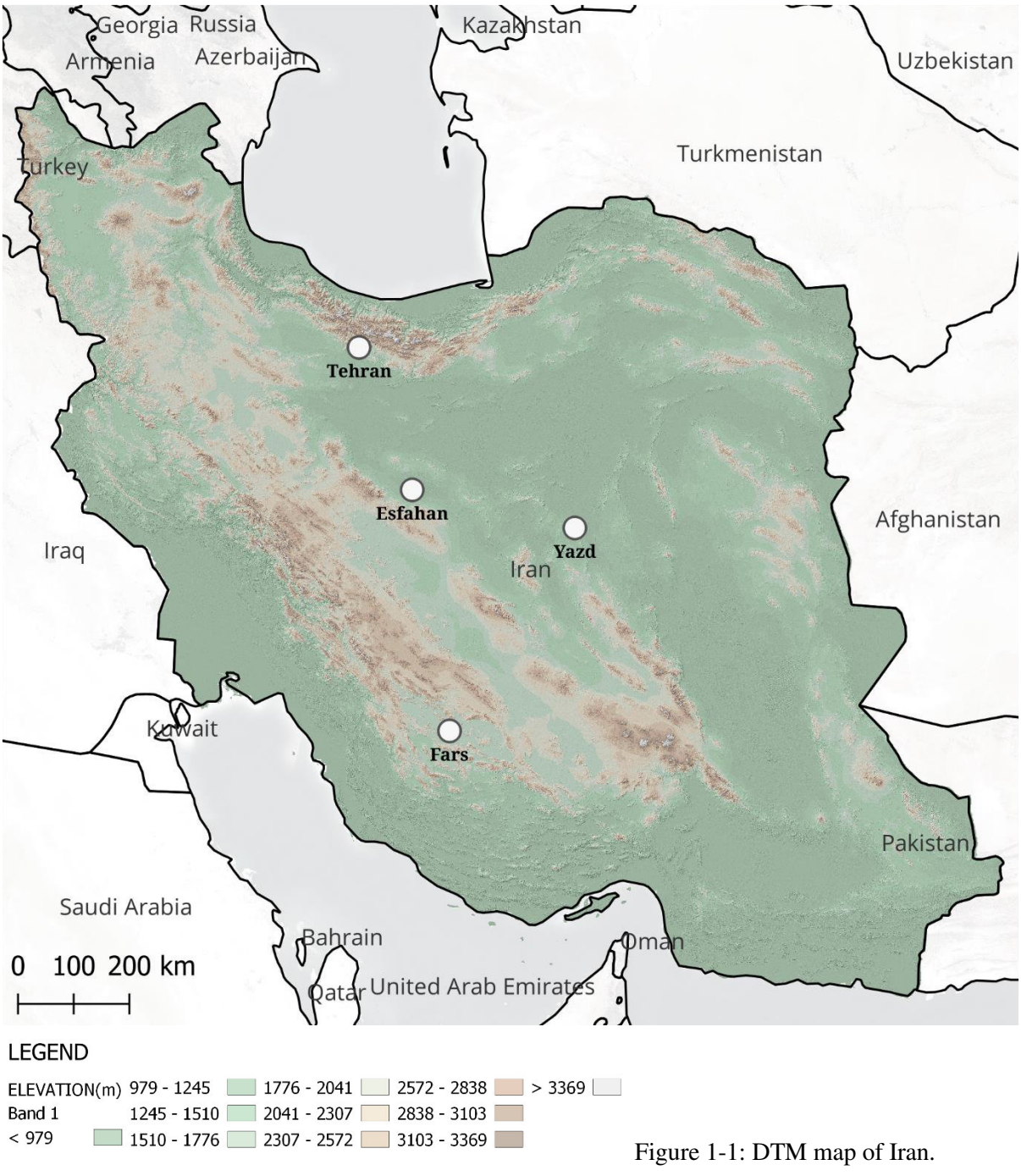


Figure 1-1: DTM map of Iran.

(National Cartographic Center)

1.1 Latitude

Latitude is the distance between two points, north or south of the equator, measured in degrees (Figure 1-2). It is significant because the solar altitude angle (the angle between the sun's beams and their reflection on the earth) and the quantity of solar radiation change with latitude (Figure 1-3).

Solar radiation and heat are distributed differently around the globe. This is related to the angle of the sun's height. Latitudes near the equator get more solar energy when the solar altitude angle approaches a perpendicular. Heat is lost at higher latitudes when the altitude angle becomes less perpendicular (Figure 1-2). [Ghobadian ,2006:22]

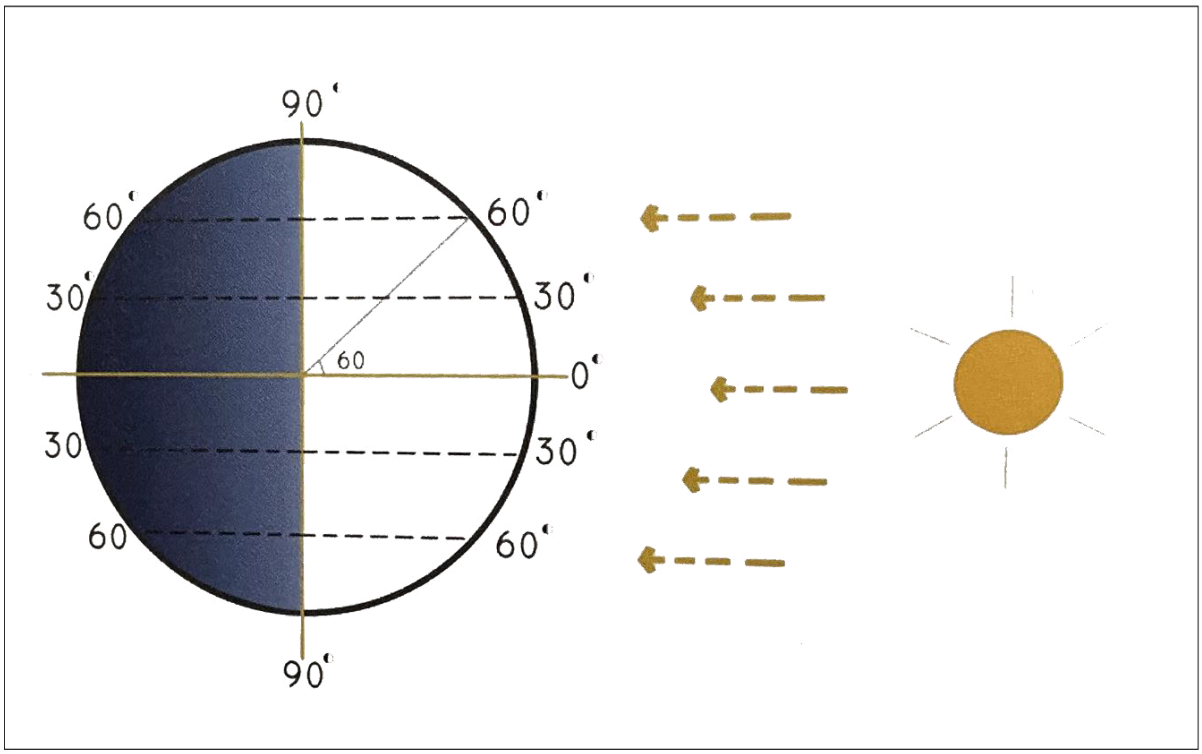


Figure 1-2: Different latitudes from equator to two poles are shown in this figure. (Diagram by Maryam Zaree)

The axis of rotation of the Earth is inclined 23.5 degrees (23.47 degrees to be exact) in proportion to the vertical of the plane of its orbit around the sun. This tilt is what causes the seasons to change. It will be summer when the axis tilts further towards the sun, resulting in greater heat and daylight. When it is winter in the northern hemisphere, it is summer in the southern hemisphere, since this hemisphere tilts more towards the sun and gets more perpendicular radiation at this time (Figure 1-4).

Flat roofs collect more solar energy (heat) than walls during the summer because the solar altitude angle is more perpendicular. The solar altitude angle is more diagonal in the winter, thus south-facing façades of buildings get more sunlight and heat in the winter and less heat in the summer (Figure 1-3).

A canopy or shade device over a south-facing window would keep even more heat from entering the building via the window (Figure 1-5). As a result, in the northern hemisphere, particularly at higher latitudes, south-facing façades and windows inherently give better comfort inside buildings, with more solar heat in the winter and less heat in the summer. In the southern hemisphere, however, the opposite is true, and north-facing façades are preferable.

Except in the hot and humid part of Iran (southern coastal region), traditional houses normally have numerous apertures on the south facing façades. As a result, most of the heat required for buildings during the winter season is generated in this manner. [Ghobadian ,2006:22]

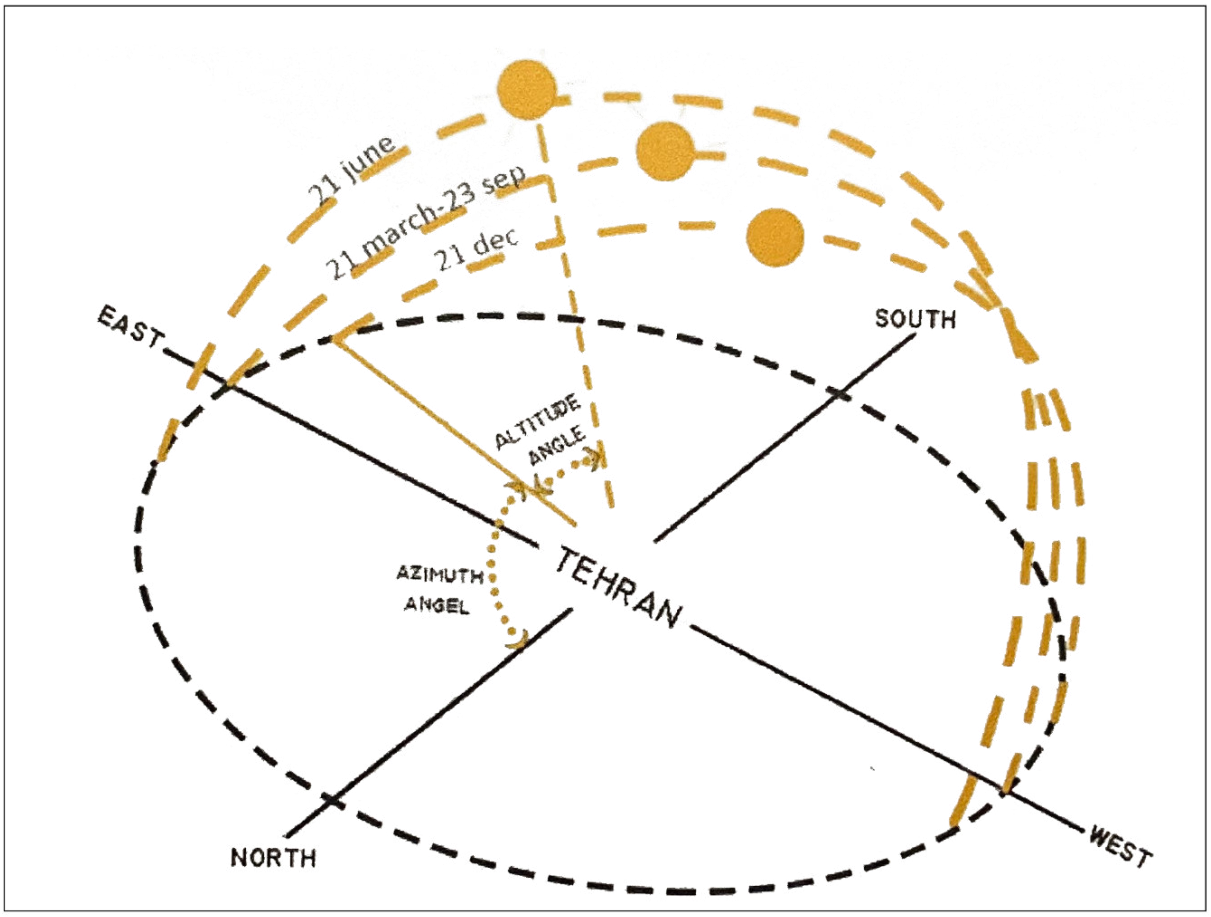


Figure 1-3: This graph depicts the solar altitude angle for Tehran. (Diagram by Maryam Zaree)
months of the year, while their interiors may be sheltered from radiation by canopies or balconies in the summer.

1.2 Altitude

The altitude of a location is its height above sea level. The climatic conditions of a location are greatly influenced by altitude. Higher elevations are associated with larger temperature changes between day and night, as well as lower air temperature and humidity.

Atmospheric air diffuses solar light and absorbs roughly 10 to 15% of it. [Mazria 1979, 10] Furthermore, air serves as thermal mass and thermal insulation between the earth surface and the outside world. Air pressure and density are lower at greater elevations than at sea level, which is one atmosphere. As a result, more solar energy reaches higher altitudes throughout the day than lower-lying locations.

Because of the earth's absorption of solar heat during the day, the temperature of the ground at night is higher than that of the atmosphere. As a result, heat radiates back from the ground to the sky at night, and since the density and humidity of the air are lower at higher altitudes, more heat radiates towards the sky at higher altitudes. As a consequence, heat changes between day and night are greater at higher heights than at lower ones.

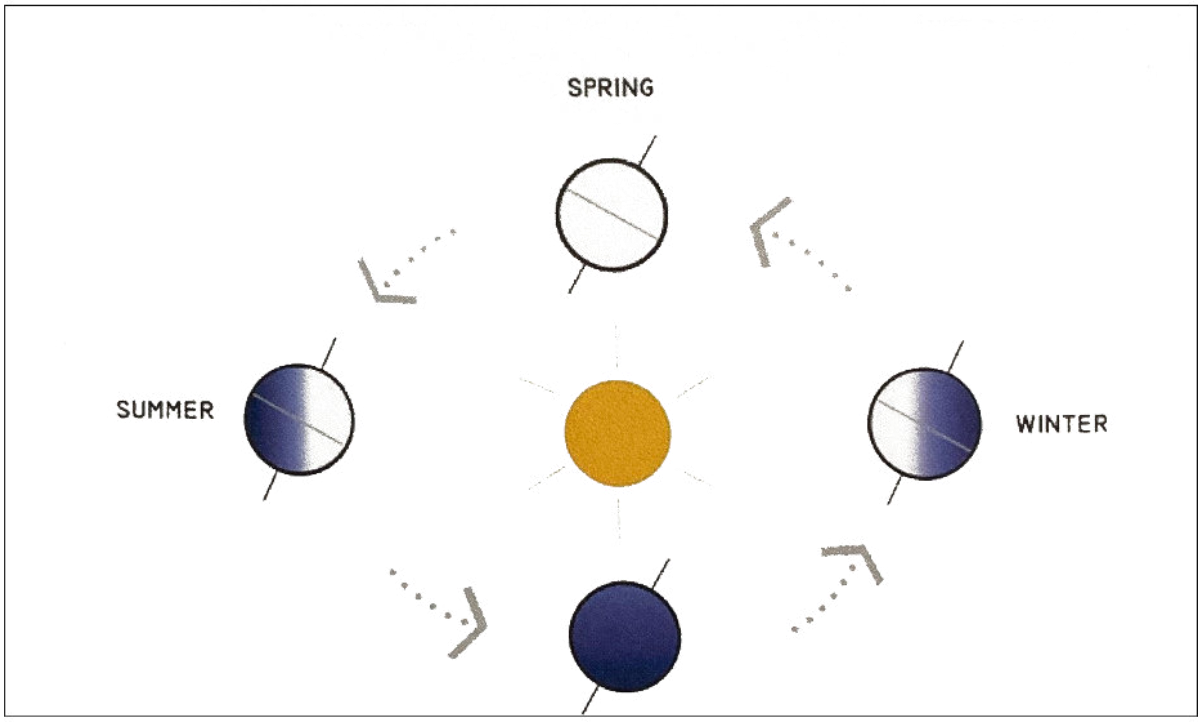


Figure 1-4: depicts the earth's incline revolution around the sun as well as the four seasons. (Photo by Maryam Zaree)

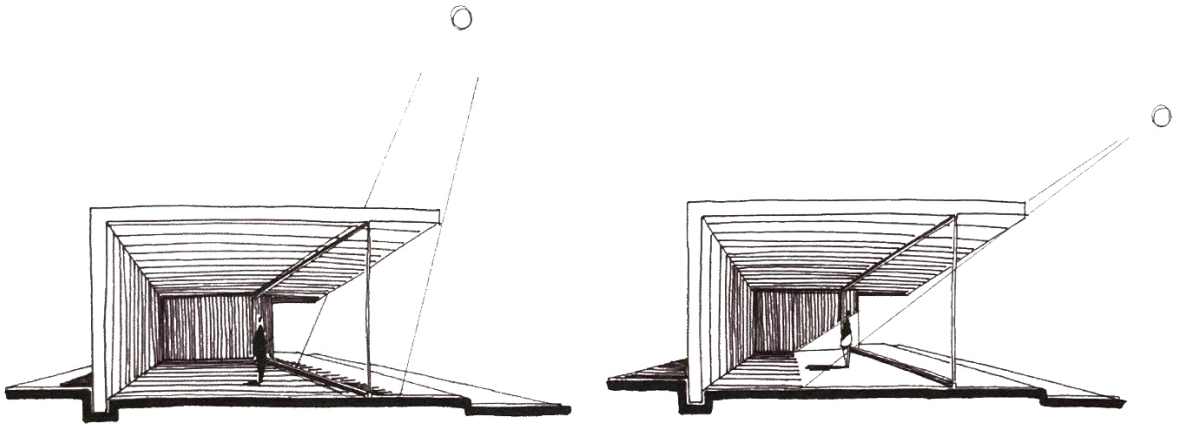
The ground loses heat and gets cooler as altitude climbs. As a result, higher levels are usually cooler. It should also be remembered that humid air is heavier than dry air, and the quantity of air humidity reduces as altitude rises.

Traditional houses in Iran's hilly and high plateau areas were constructed using masonry materials such as stone, brick, or adobe. These construction materials have large thermal masses and may keep heat from the day till the night. As a result, traditional building interiors were quite warm and cozy (refer to chapter five for more details).

1.3 Distances from Sea

As previously stated, air pressure is higher at sea level, which implies there is less temperature variation between day and night near the water. Furthermore, water has a far higher thermal mass than ground and masonry materials. As a result, water may retain a significant amount of heat from the day into the night.

Seacoast breezes arise due to the temperature differential between land (which has a higher temperature during the day) and sea (which has a greater temperature at night). Furthermore, in coastal places, the air is more humid, and humid air has greater thermal mass than dry air. Because of all of this, there is substantially less temperature variation between day and night in coastal locations than further inland, particularly at higher elevations.



summer winter

Figure 1-5: Because of the higher inclined solar elevation angle in winter, south-facing windows (in the Northern hemisphere) allow in more solar heat.
(Sketches by Ali Tavakoli)

High relative humidity, caused by water evaporation, is an essential climatic factor near a sea or ocean. During the warmest months of the year, this produces sweat and discomfort for individuals. Shade and ventilation are two natural ways to provide pleasant circumstances in such settings (refer to chapters three and six for more details).

The quantity of precipitation is directly affected by distance from the sea or ocean, latitude, height, and wind direction. Precipitation is essential for the survival of the many types of life on land. Precipitation is required for practically all land life to exist. Greater precipitation would result in more green space and animal life in any location.

In terms of humans, when there is more rainfall, there is more flora, fresh water, and humidity. Buildings should be protected against heavy rainfall and ground moisture in such cases. Traditional Iranian structures in such circumstances were frequently built with masonry and materials made of plants and trees to protect them from moisture and dampness (refer to chapter three for more details).

The air motions that generate wind are caused by solar radiation, differences in height and thermal mass on the planet's surface, and the rotation of the world around its axis. Wind delivers clouds and rain, which are essential for life on Earth; without it, human existence would be impossible.

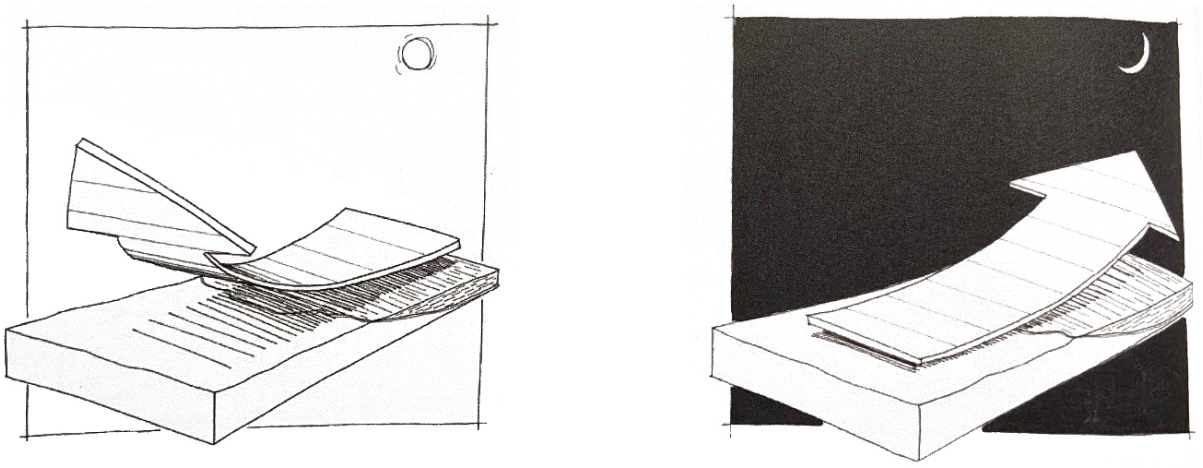


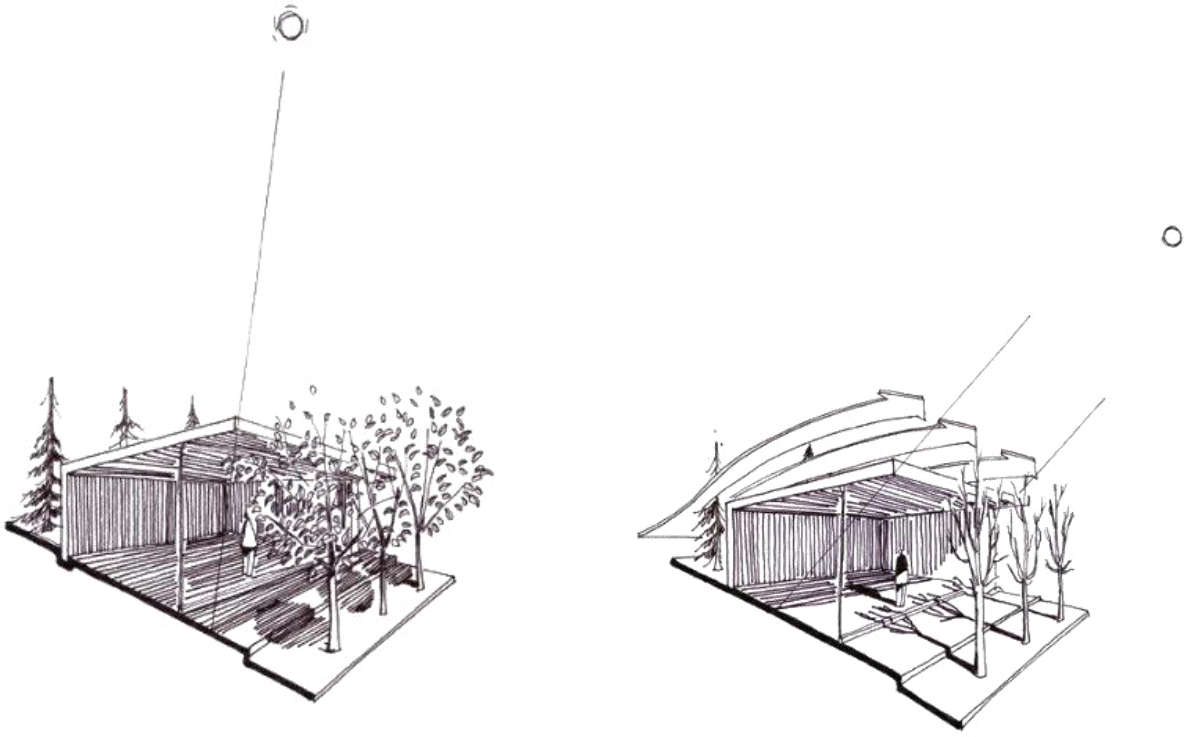
Figure 1-6: A sea wind throughout the day. The night breeze from the land (Sketches by Ali Tavakoli)

Rain clouds form in Iran from the Indian Ocean and the Mediterranean Sea. Another wind current sweeps from the north (Siberia), bringing frigid weather with it. Winds from the Arabian Desert blow towards the south, preventing rain-making clouds from forming. Furthermore, every location has local winds that might blow from any direction.

Traditional houses were erected in the moderate environment of the Caspian Water coasts to take advantage of the winds between the land and the sea for cooling in the summer. They did, however, need to be shielded against westerly winds since there are strong gusts that allow rain to impact the western walls of structures. Without protection, the western walls of structures would have been always moist and would have eventually collapsed.

Wind towers and building apertures utilized winds between land and sea for cross ventilation in structures in several cities and villages along the country's southern coasts. Urban areas and structures in the country's primarily chilly region were shielded from harsh winter winds. Towns, villages, and structures in the central plateau region, particularly near desert regions, were shielded from winter winds and desert sandstorms (the so-called black winds).

Manmade habitats were built in such a manner that they may be shielded by natural factors such as mountains and hills in order to redirect these unpleasant winds. Winds were sometimes deflected by erecting tall and lengthy barriers or planting evergreen plants.



summer winter

Figure 1-7: Deciduous trees help shelter structures from summer solar heat. Winter cold wind and sand storms may be mitigated by evergreen trees.
(Sketches by Ali Tavakoli)

Wind direction was significant in the construction of various cities and villages, such as Maybod in Yazd and Rahim-Abad in Khorasan, which are located on the outskirts of the Dasht-e Kavir desert. The whole urban fabric and the structures within it, as well as the majority of its openings, were orientated towards the cool summer breezes that come from the hillsides, with their backs facing the desert's sandstorms and sandy winds. As a result, wind was one of the most significant factors in shaping and orienting man-made surroundings in this area.

Wind may be directed into or out of the structure and site, and it can be prevented or redirected in a variety of ways. Traditional wind towers (Badgeers, meaning wind collectors) were one of the most effective strategies in Iran for bringing in cool summer winds for cross ventilation.

1.4. FOUR DIFFERENT CLIMATES OF IRAN

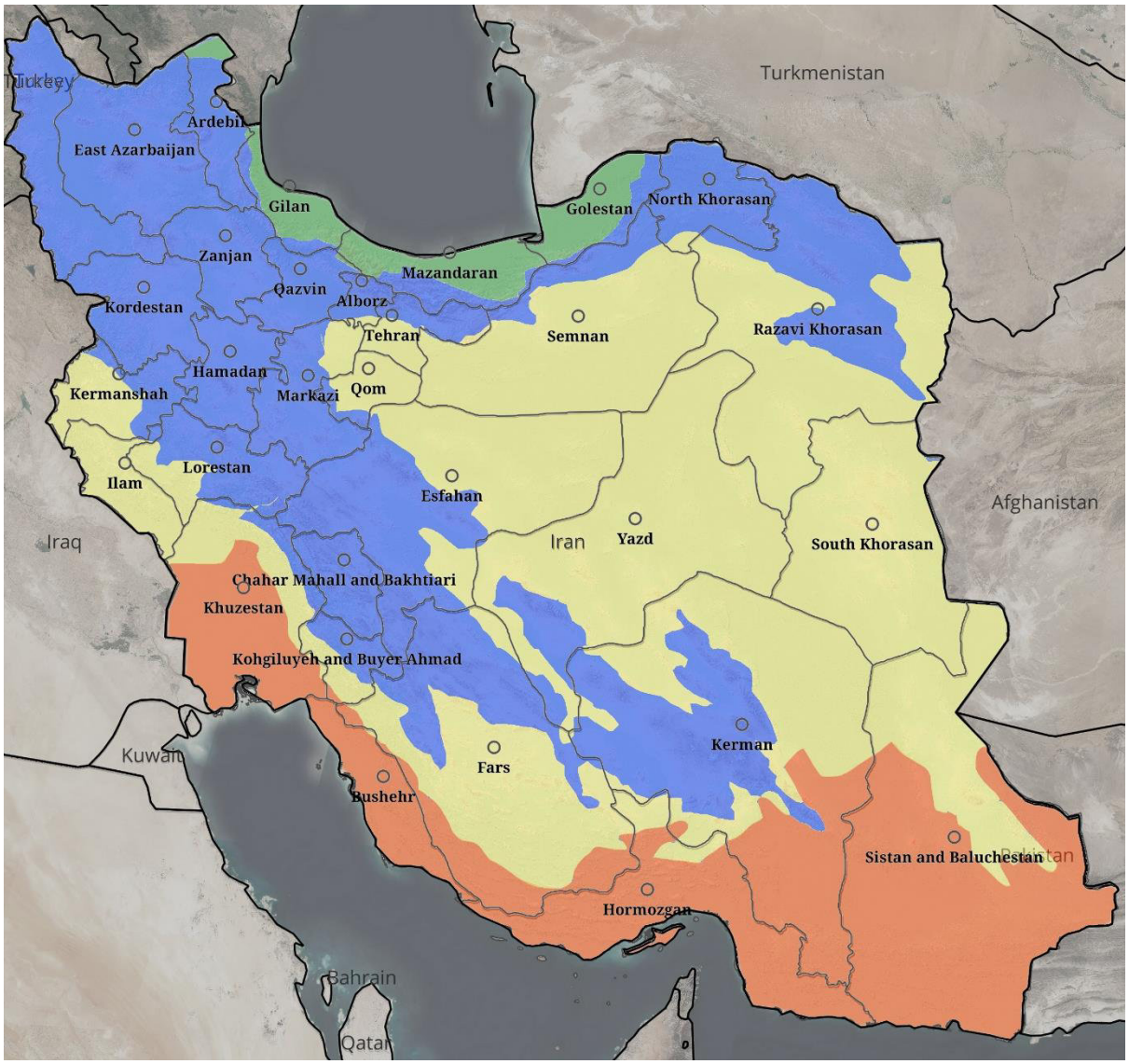


Figure 1-8: four main climate regions of Iran (national cartography center)

The Northern Coastal Region – Temperate Climate

The Southern Coastal Region – Hot and Humid Climate

The Mountainous and High Plateau Region – Cold Climate

The Central Plateau Region – Hot and Dry Climate

CHAPTER 2

IRAN'S MORPHOLOGY INTERPRETED BY LANDSCAPE ANALYSES

IRAN GEOGRAPHICAL AND HISTORICAL INFORMATION

Iran is a nation in southwestern Asia that is hilly, arid, and ethnically diverse. The country has a rich and distinct cultural and social continuity that dates back to the Achaemenian era (550 BCE). Geographically, much of Iran is made up of a central desert plateau surrounded on all sides by tall mountain ranges that provide access to the interior via high passes. The majority of the population lives on the outskirts of this forbidden waterless waste. Tehran, a large jumbled city at the southern foot of the Elburz Mountains, is the capital. The city, known for its beautiful architecture and lush gardens, fell into ruin in the decades after the Iranian Revolution of 1978-79, however efforts were later launched to conserve historic structures and expand the city's park network. Cities such as Esfahan and Shiraz, like Tehran, mix modern architecture with historical landmarks and serve as significant centers of education, culture, and commerce. Iran, the core of the famous Persian empire of antiquity, has long played a significant role in the area as an imperial force and, subsequently, as a player in colonial and superpower rivalry due to its strategic position and copious natural resources, particularly petroleum. The territory that is now Iran—traditionally known as Persia—has been impacted by waves of indigenous and foreign invaders and immigrants since the Achaemenian period, notably the Hellenistic Seleucids and local Parthians and Sasanids. The invasion of Persia by Muslim Arabs in the 7th century CE, however, was to have the greatest enduring impact, since Iranian culture was all but totally absorbed by that of its invaders. [Mostofi, K., Afary, Janet and Avery, Peter William]

Geographic Information System (GIS) analysis has become increasingly popular in recent years due to its ability to provide a comprehensive view of geographical information. Iran, a country with a rich history and diverse geography, has been the subject of many GIS studies, providing valuable insights into various aspects of the country. However, conducting a GIS analysis in Iran is not without its challenges. One of the main challenges is collecting accurate and reliable data, which is often hard to come by. This is particularly true in a country like Iran, where political, cultural, and economic considerations can make it difficult to gather information.

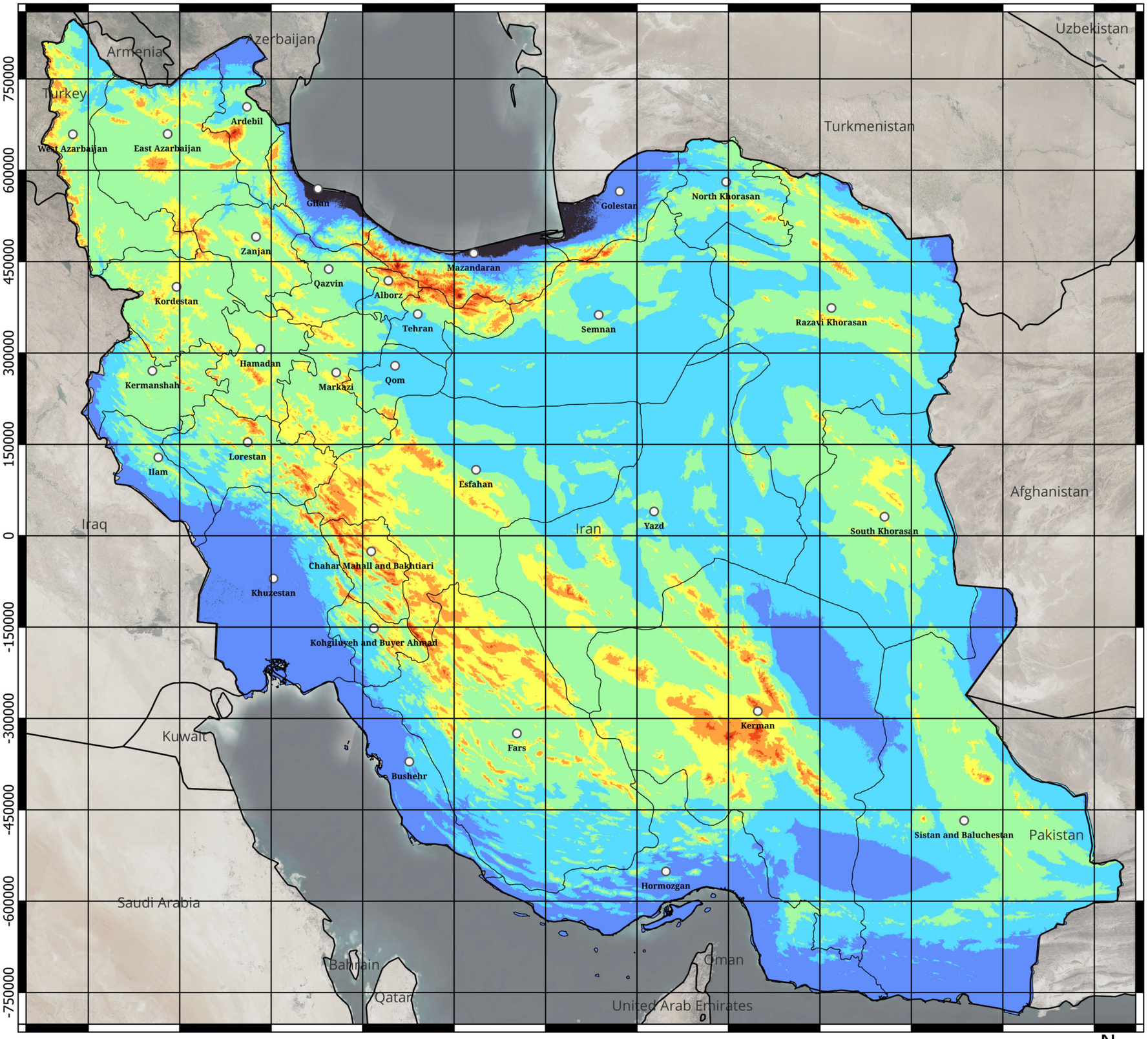
The source of data for this GIS analysis is the National Cartography Center of Iran. This organization is responsible for creating and maintaining maps and geographical data for the country. The data used in this analysis is based on the WGS84/UTM Zone 39N coordinate system, which is widely used in GIS applications. This coordinate system allows for the precise representation of geographical information, making it an ideal choice for this analysis.

Despite the challenges faced in collecting information, GIS analysis has become an essential tool for understanding and analyzing the complex geography of Iran. From its vast deserts to its towering mountains, Iran's diverse landscape provides a wealth of information that can be analyzed using GIS technology. Whether it is to study the distribution of natural resources, analyze demographic trends, or understand the impact of human activities on the environment, GIS analysis is an essential tool that provides valuable insights into the country.

In conclusion, conducting a GIS analysis in Iran presents unique challenges due to the difficulties in collecting reliable data. However, the data provided by the National Cartography Center of Iran, combined with the WGS84/UTM Zone 39N coordinate system, allows for a comprehensive analysis of the country's geography. Despite the difficulties, GIS analysis remains a valuable tool for understanding the complex geography of Iran and providing valuable insights into the country's diverse landscape.

ELEVATION AND CITIES OF IRAN

This map shows the elevation of Iran, as we can see the coast of caspian sea is under sea level
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
spatial scale 1:10000
Map Scale 1:6500000



LEGEND

ELEVATION (m)
Band 1

<= 0	
0 - 500	
500 - 1200	
1200 - 2000	
2000 - 2500	
2500 - 3200	
3200 - 4000	
> 4000	

0 100 200 300 400 500 km

N

MAP SCALE 1:6500000

NATIONAL CARTOGRAPHIC CENTER
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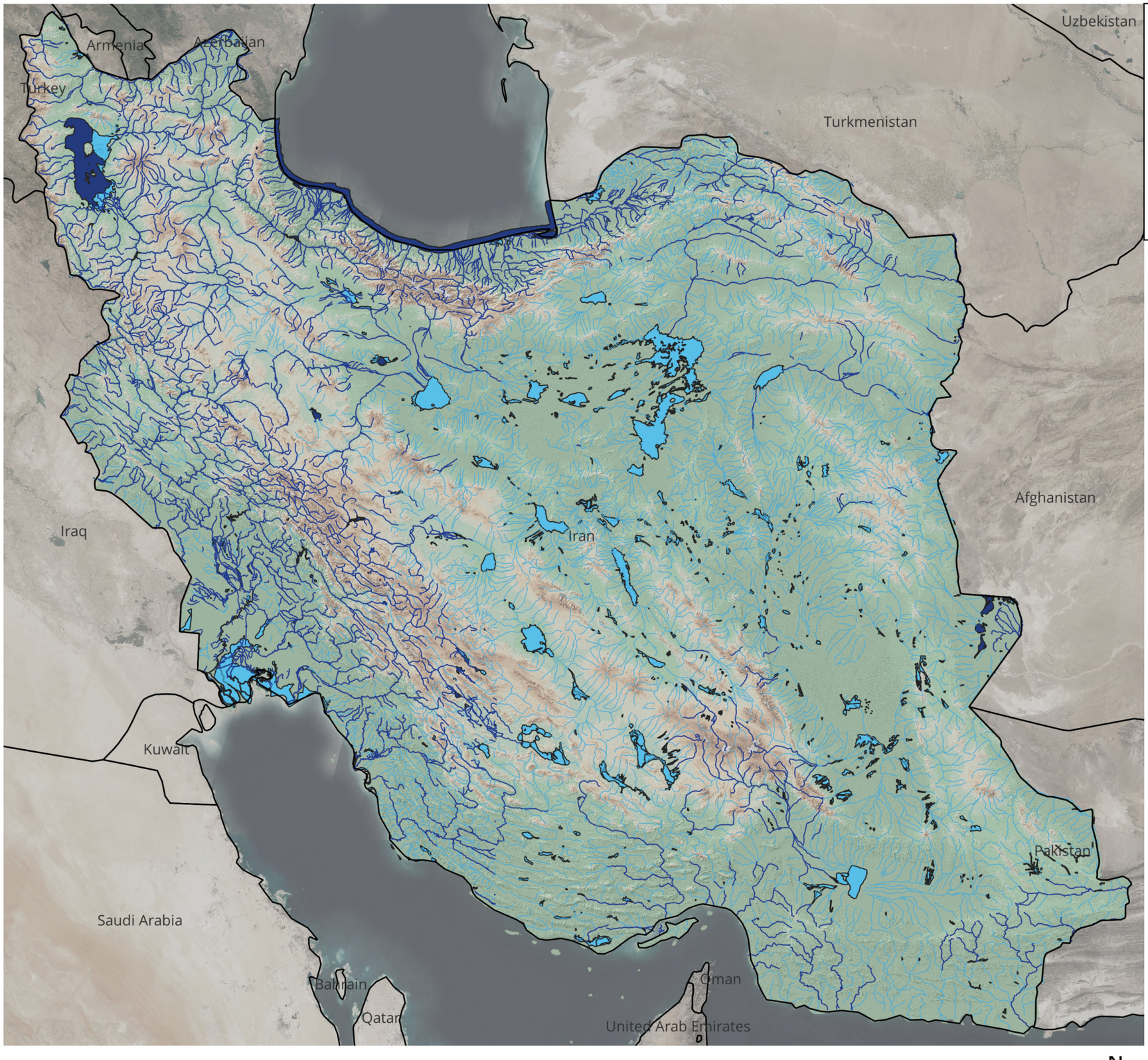
ELEVATION, RIVERS AND LAKES OF IRAN



This map shows the elevation and situation and location of rivers and lakes. According to the map, most of the permanent rivers are located in the west of the country where the weather is more pleasant than center of Iran.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
Map Scale 1:6500000

LEGEND

ELEVATION (m)
Band 1
< 979
979 - 1245
1245 - 1510
1510 - 1776
1776 - 2041
2041 - 2307
2307 - 2572
2572 - 2838
2838 - 3103
3103 - 3369
> 3369

LAKES
Intermittent
Permanent

RIVERS
Intermittent
Permanent

0 100 200 300 400 500 km

MAP SCALE 1:6500000

N

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ELEVATION, CITIES AND ROADS OF IRAN

This map shows the elevation and different types of roads and city borders also countries around Iran are visible.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
Map Scale 1:6500000

LEGEND

ROADS
Primary Route
Secondary Route
REGION BOUNDARY

ELEVATION (m)
Band 1
< 979
979 - 1245
1245 - 1510
1510 - 1776
1776 - 2041
2041 - 2307
2307 - 2572
2572 - 2838
2838 - 3103
3103 - 3369
> 3369

0 100 200 300 400 500 km

MAP SCALE 1:6500000

N

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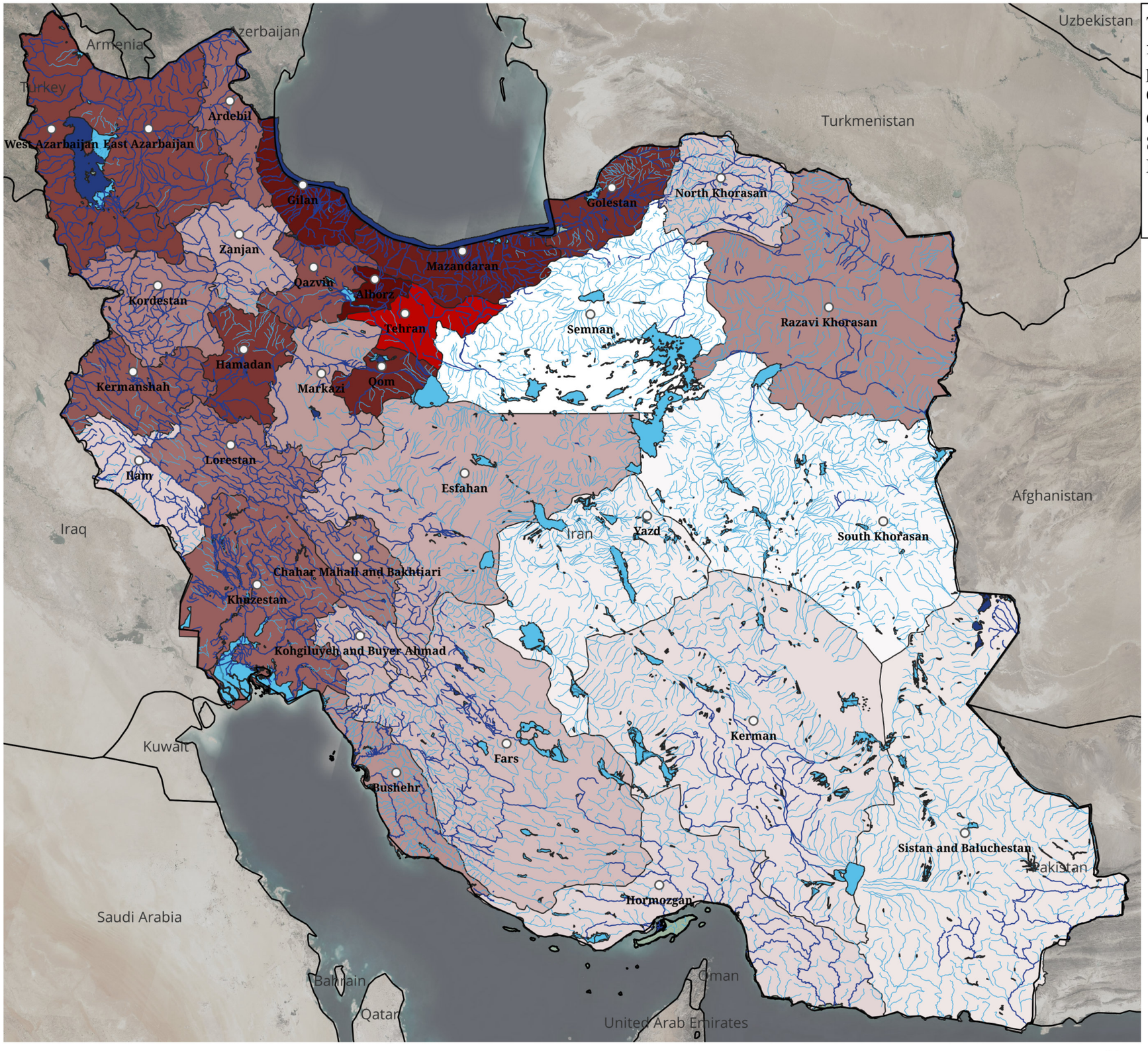
LAKES,RIVERS AND POPULATION OF IRAN



This map shows the population of each region in Iran and we can find out cities that have more permanent rivers are more populated than other cities in the central of the country.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
Map Scale 1:6500000

LEGEND

LAKES
Intermittent
Permanent

RIVERS
Intermittent
Permanent

POPULATION (P/KM2)
969.2
529.4
180.2
137.7
112.1
91.8
89.7
87.3
85.6
81.8
78.1
73.5

71.4
62.2
58.0
55.0
54.1
51.2
49.1
48.6
47.9
46.0
40.2
30.4
28.8
25.1
17.3
15.3
8.8
8.1
7.2

0 100 200 300 400 500 km

MAP SCALE 1:6500000

N

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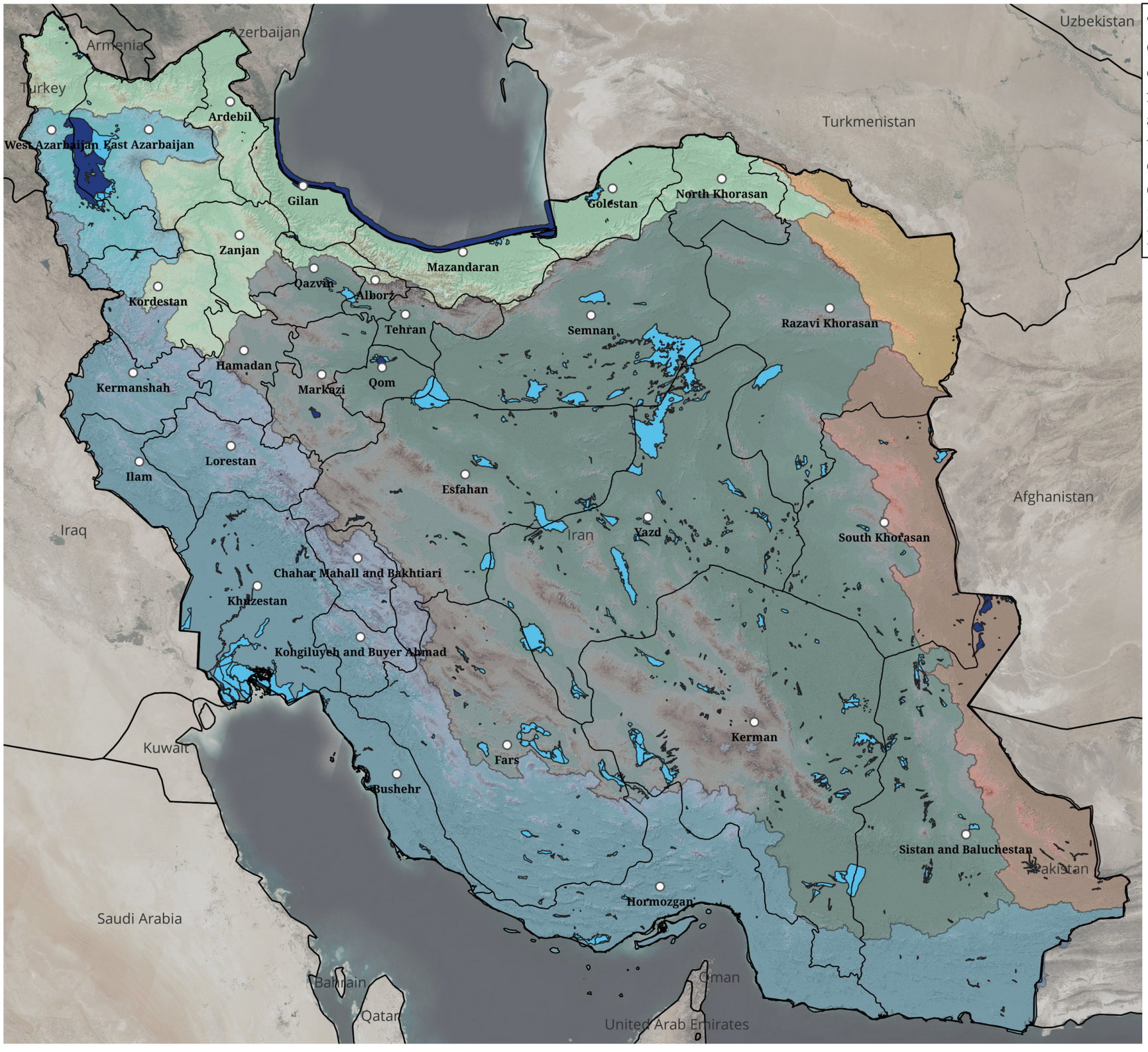
ELEVATION,LAKES,CITIES AND BASIN OF IRAN



This map shows the basin in Iran is categorized in 6, Persian Gulf and Oman Sea which is in covered the south and west of the country and Urmia lake and Caspian sea covered north and north-west otherwise Oara Oom and Eastern boarder coverd east and biggest basin is Central Plateau which is covered the most of the country.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
Map Scale 1:6500000

LEGEND

BASIN
- Persian Gulf and Oman Sea
- Urmia Lake
- Caspian Sea
- Central Plateau
- Qara Qom
- Eastern Border

LAKES
- Intermittent
- Permanent

REGION BOUNDARY

ELEVATION (m)
Band 1
- < 979
- 979 - 1245
- 1245 - 1510
- 1510 - 1776
- 1776 - 2041
- 2041 - 2307
- 2307 - 2572
- 2572 - 2838
- 2838 - 3103
- 3103 - 3369
- > 3369

0 100 200 300 400 500 km

MAP SCALE 1:6500000

N

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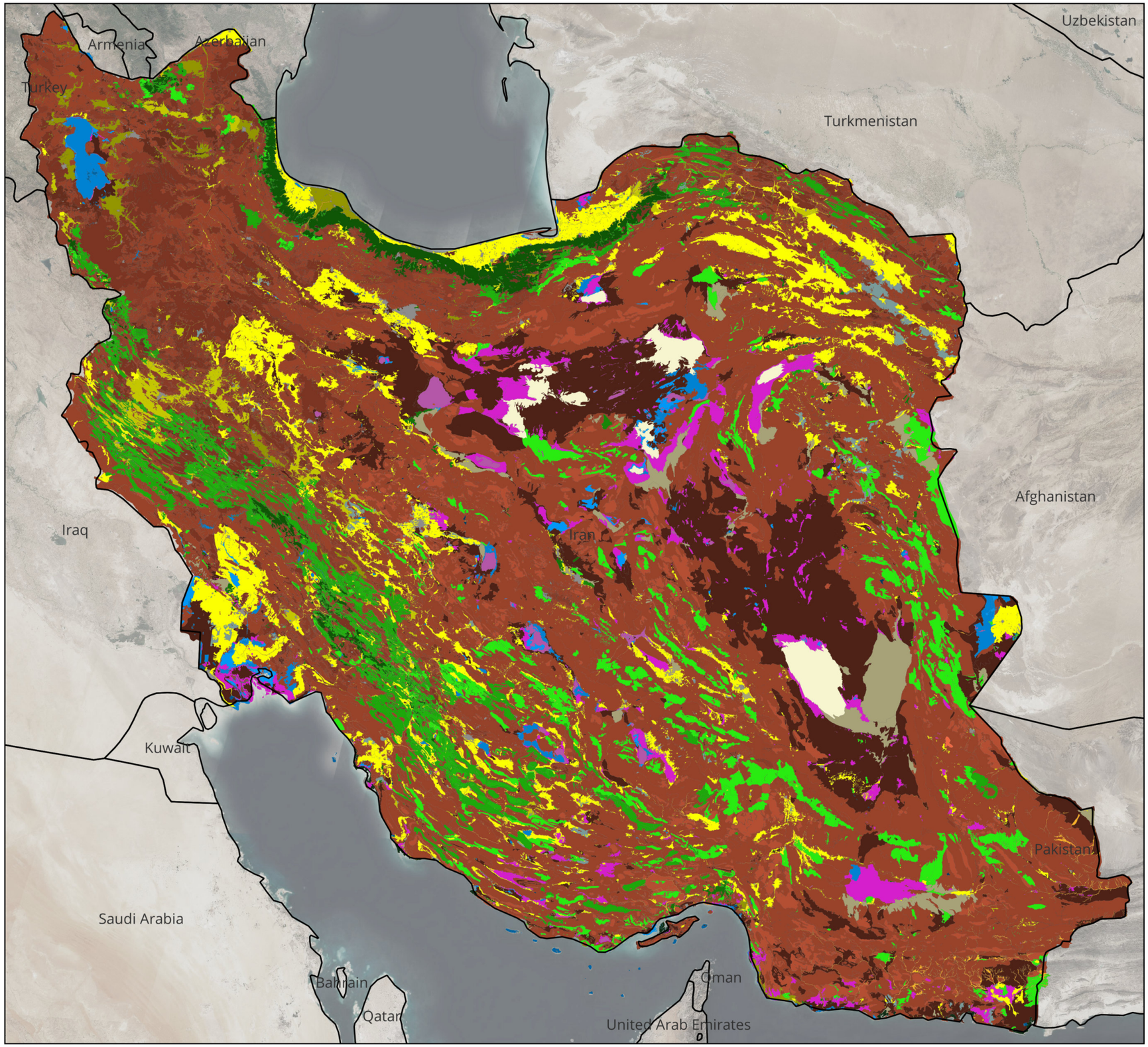
LAND USE OF IRAN

This map shows the land use in Iran and s we can see there is not much forest areas and water areas in country.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
spatial scale 1:10000
Map Scale 1:6500000



LEGEND

Landuse	Rock_Bare Lands
Agriculture	Rock_Poor Range
Agriculture_Dry-Farming	Aquifer (Abkhan)
Agriculture_Garden	Fishery Pool
Dense Forest	island
Forest	shoreline
Forest_Sanddune	Water-Lakes
Forest_Wood-Lands	wetland
Low Dense Forest	Wetlands
Moderate Dense Forest	Desert
Wood-Lands	Mangro
Bare Lands	Masil
Garden	Mixture
Dry-Farming	saltlake
Garden_useless	Salt Lands
Good Range	Sanddune
Moderate Range	Urban
Poor Range	
Rock	

0 100 200 300 400 500 km

MAP SCALE 1:6500000

N

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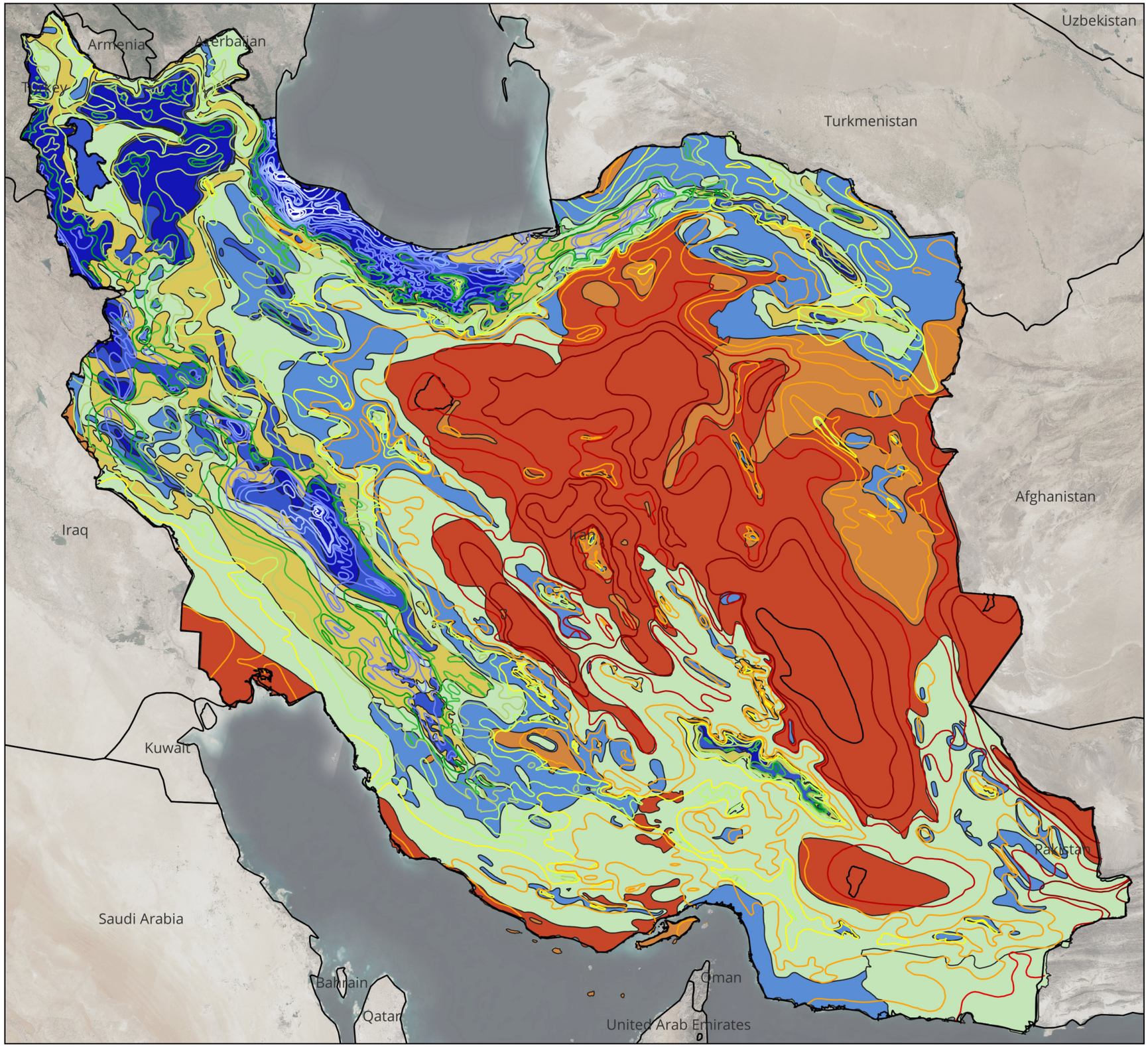
CLIMATE AND RAIN ANALYSIS OF IRAN

This map shows the climate and rain analysis of Iran, as we can see center of country is dry but west and north is more humid.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:28x28
Spatial Resolution: 15m
spatial scale 1:10000
Map Scale 1:6500000



LEGEND

Climatology		350
very dry		400
Dry		450
Mild semi-dry		500
Medium semi-dry		550
Semi-dry		600
Sub-humid		650
Humid		700
Rain(mm)		800
5		900
25		1000
50		1100
75		1200
100		1300
101		1400
125		1500
150		1600
200		1700
250		1800
300		

0 100 200 300 400 500 km

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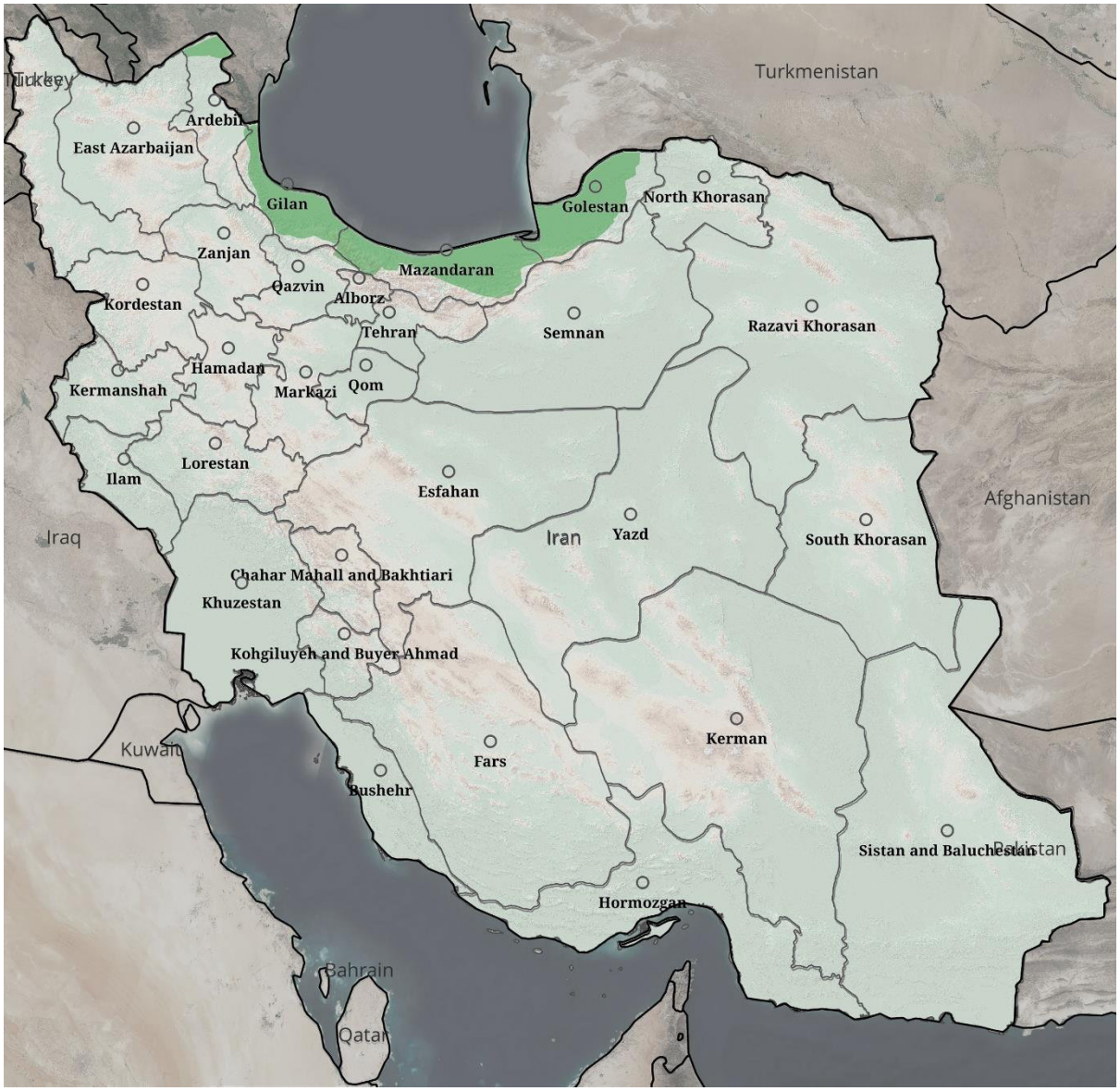
CHAPTER 3

ANALYSIS OF SUSTAINABLE BUILT HERITAGE IN FOUR DIFFERENT CLIMATES

3.1. THE NORTHERN COASTAL REGION Temperate Climate

This area, which spans along the southern beaches of the Caspian Sea, has the greatest amount of precipitation in the nation, extensive forests in its heights, and intense agricultural usage in its lowlands. Winters are frigid, while summers are hot and humid. "Average annual precipitation is between one and two meters, and relative humidity is over 70% all year" [Kasmaee 2003, 209-295].



3.1.1. Climatic Conditions

This area receives much more precipitation than the other climatic zones in the nation. To the south, the Alborz Mountain range prevents clouds from migrating south and into the remainder of the nation. As a result, clouds from the Caspian Sea get stuck there. The western section of this area receives higher rainfall, with an annual precipitation of roughly two meters and an average relative humidity of eighty percent. The quantity of precipitation, relative humidity, and tree and plant density decreases towards the east. The yearly precipitation in the eastern section is around 65 cm, and the annual average relative humidity is approximately sixty percent. [Kasmaee, 2003, 209-295]

The region's climatic characteristics are as follows:

1. Heavy rainfall, particularly in the autumn and spring, and snow in the winter.

2. Consistently high relative humidity throughout the year

3. There aren't many temperature differences between day and night.

4. Winters are cold, while summers are hot and humid.

5. entirely covered with trees and plants This area runs over 600 kilometers and has a breadth of 20 to 80 kilometers.

This long yet narrow piece of land has two distinct sub climates and natural habitats.

The northern slopes of the Alborz Mountain Range, which are densely forested, lie to the south. The weather is frigid in the winter and warm in the summer. In its hilly areas, there are only villages and small towns, and the economy is focused on animal husbandry, forestry, and handicrafts.

The lowlands between the mountain and the Caspian Sea were formerly covered with trees and marsh flora many millennia ago. They are currently totally covered with agricultural lands, cities, and communities. Winters are not as chilly here as they are in the highlands, and summers are hot and humid. Agriculture, fishing, manufacturing, tourism, and handicrafts are the mainstays of the lowland economy.

Figure 3-1: Aerial picture of the historic area of Gorgan, the provincial capital of Golestan.
(Photo by Faezeh Kaboli)


Figure 3-2: View of a mountainous forest in the background and agricultural fields in the foreground.
(Photo by Arsalan Chabok)

3.1.2. Urban Fabric

Humidity is a serious issue in regions near the seaside or with considerable rains. Wet air is heavier than dry air and is put beneath it. As a result, if urban areas are contained and air and wind do not move, all of these spaces will be gathered from moist air in the city, making breathing and activities difficult.

As a result, airflow should be optimized to avoid excessive humidity from settling in metropolitan areas. [Ghobadian ,2006:38] As a result, buildings in these regions are erected independently, with courtyards and vast open spaces, and walls around these spaces that are typically less than human height.

The utilization of airflow to travel through structures and bring damp and stagnant air out of enclosures and bio-spaces is the cause behind this. Another motivation to connect the living environment with nature is to take use of the region's gorgeous and lush ecosystem. The following are the general features of urban and rural texture in this region. [Ghobadian ,2006:40]

The following were the primary characteristics of the region's urban fabric:

1. Urban areas were partially open on either side.

2. Buildings were dismantled

3. The streets were broad and open on both sides.

4. Seaside towns dotted the shoreline. In this manner, the sea breezes were used to keep people cool.

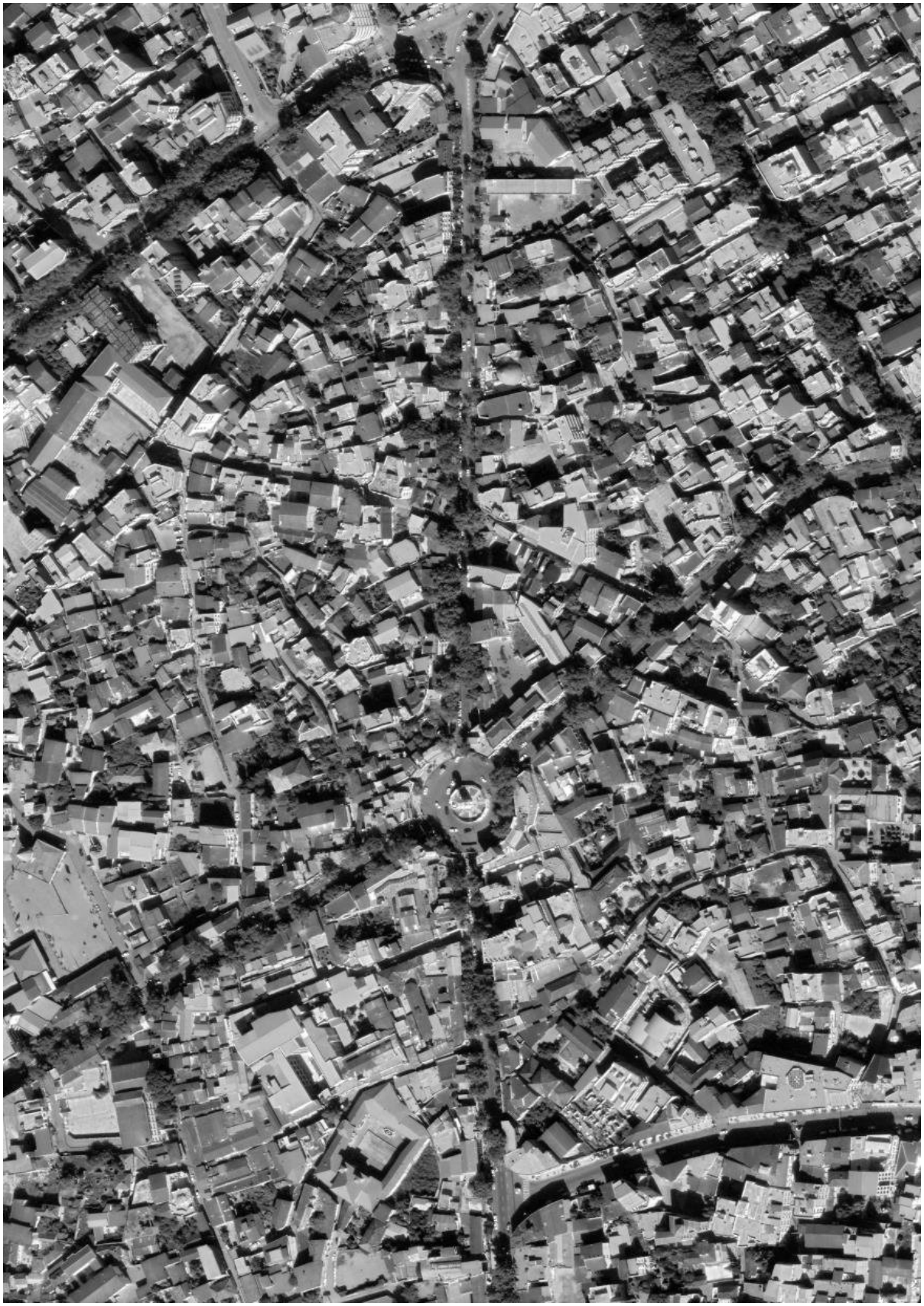


Figure 3-3: Aerial photograph of city of Sari. (Google earth)

Figure 3-4: An aerial view of the old section of Gorgan, the capital city of the Golestan
In this city all the traditional buildings have gable roofs. Most of the buildings are outward oriented. Some have central courtyards with openings around them and also opening on the outside wall. (Photo by Faezeh Kaboli)

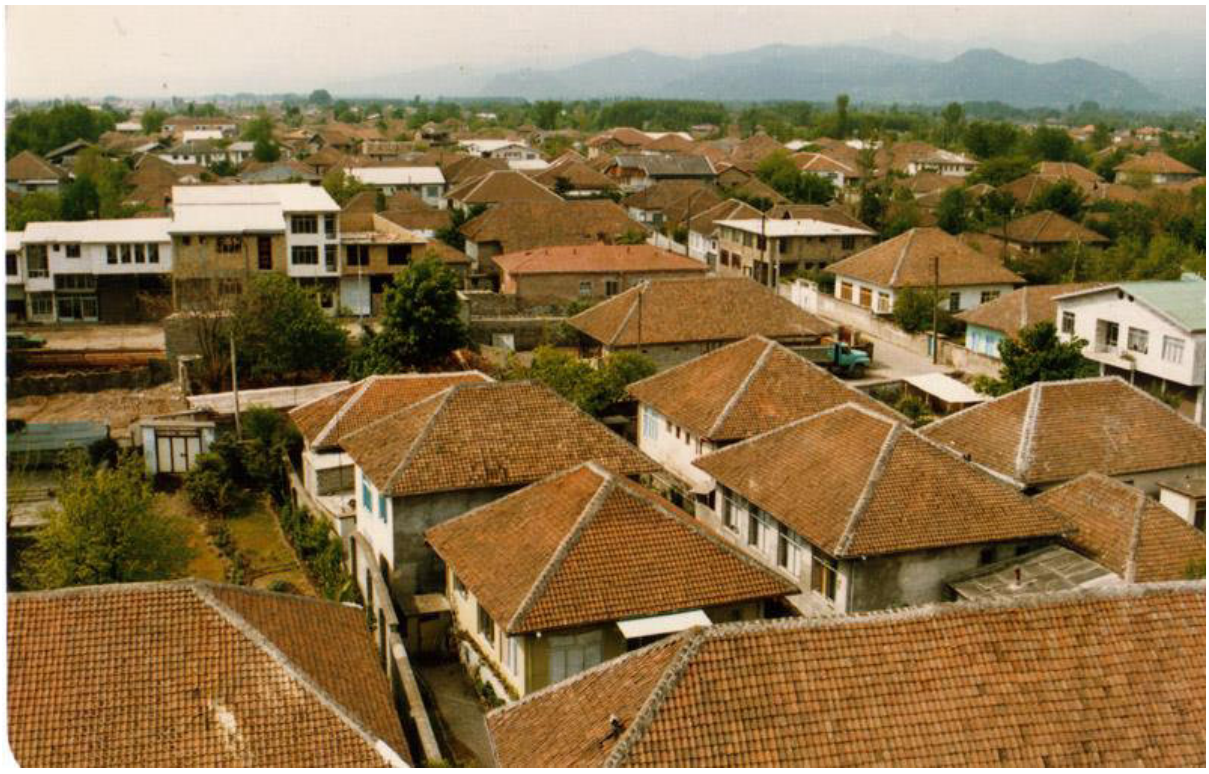


Figure 3-5: The urban form in Astara (to the north-west of the Gilan Province) has wide open spaces and detached buildings. (Photo by unknown)

Figure 3-6: Aerial view of the city of Rasht which is the largest city in this region. n (Photo available in Nody.ir)

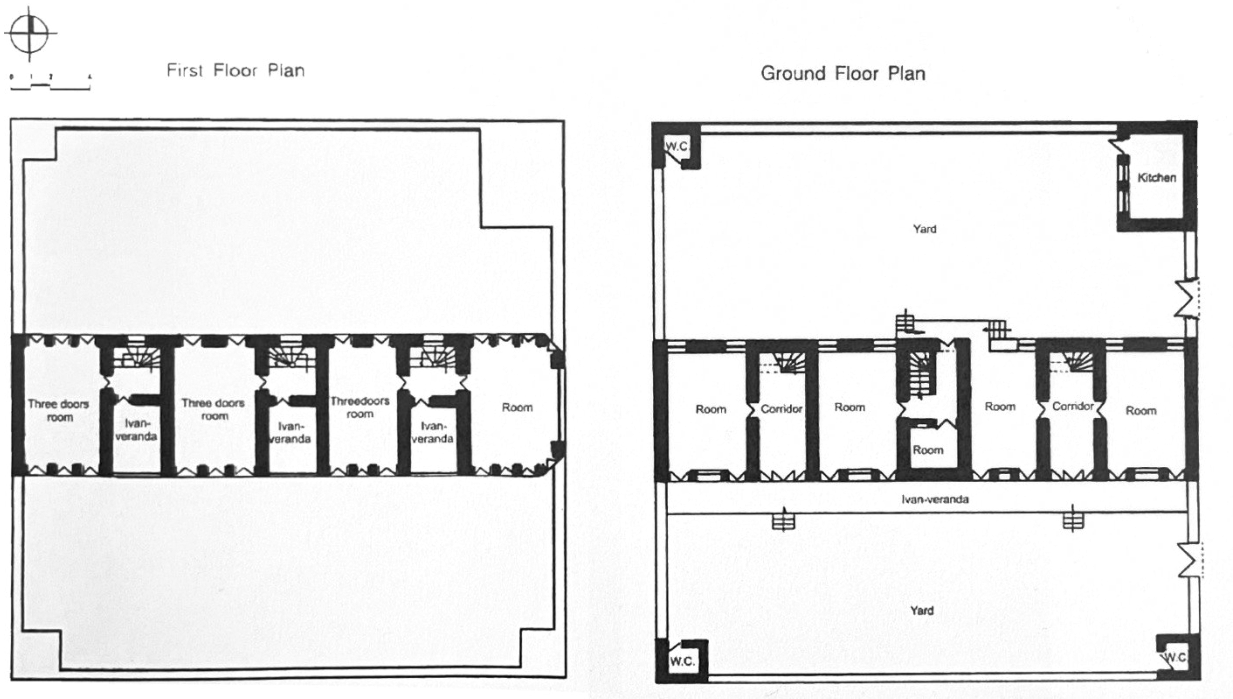


Figure 3-7: Using cross ventilation is a common practice in all building spaces in the northern coastal region, as shown in the above plans, related to a house in Amol, a city in the Mazandaran Province. (Courtesy of Housing and urban Development)

3.1.3. Building Form

This region's architecture, particularly its dwellings, were designed to promote human comfort in the face of several severe weather variables. Heavy rains, high subterranean water levels, hot and humid weather in the summer, and cold temperatures in the winter are all factors.

A. Extravagance

Mazandaran's indigenous architecture is so entwined with nature and in accordance with climatic circumstances that it may be dubbed 'naturalistic' architecture. An architect renowned as extroverted architecture for reacting to environmental and climatic circumstances [Shahroudi, page 37] is the reason for the development of extroverted structures in this region, firstly to avoid moisture from lingering in the building, and the other reason is to make the most use of moisture by developing a suitable landscape and surveying the yard area. [Gorgi Mahlbani, 2010:142]

Extravagant typology is experienced with a kind of house design that has features such as a visible and physical interaction with the outside world, a lack of a yard, altitude extension, and arranging space above another space such as corridors. [Zandieh, 2010:8]

B. The dominant form and orientation of the building

Free and even crucifix-shaped shapes may be employed in these locations. However, in order to provide the requisite cross ventilation, the building design must be stretched along the eastern-western axis. [Gorgi Mahlbani, 2010:142] The primary front of most rooms and porches' illumination is on the south side.
The main courtyard of the building is also on the south side. [Kasmai, 2008:24] In general, the plans are wide and open, and their physical form is mostly geometric, long and narrow shapes; to maximize the use of wind in creating ventilation inside the rooms, the direction of the buildings is determined by the direction of the sea breezes; and in places where strong winds blow, the windy part of the buildings is completely closed. [Kasmai, 2003:87]

C. Four seasoning of the building

Seasonal migration occurs in the dwellings of this region, much as it does in the four seasons houses in hot and arid locations, where inhabitants migrate from north to south according to the seasons. Thus, throughout the winter, the most significant activities take place on the first level. During the warmer season, however, these activities are performed on the porch, particularly the porch of the second floor (telar) and the second-floor chamber (telar room). [Ghobadian, 2006:64]

D. Connect with earth

In Mazandaran, architectural interplay with land and environment is accompanied by both adherence and usage. [Kolbadinejad, page 84] Because of the humidity in the air and the shallow depth of the groundwater, the ground floor of the building strives to run even above the typical surface of the ground so that the floor is distant from the earth's dampness and may benefit from wind flow that is higher in height than the greater speed. [Ghobadian, 2006:42]

This distance is around two meters in structures near the sea and 50 cm or less in buildings in the foothills. Because of its exposure to shade and air, this area is utilized for chicken storage (stratum), drying wood from trees, equipment storage, and is sometimes used as a barn. In reality, the kind of user of this place is determined by the quantity of moisture in various locations. [Kolbadinejad, page 85]

E. No basement

Figure 3-8: Ramedani house in Sari, the capital city of Mazandaran Province, has gable roofs and roof tiles on top and windows all around. (Photo by Arsalan Chabok)

Figure 3-9: For cross ventilation, there are windows on opposite sides of all the rooms on the upper floor of the Kolbadi House in Sari. (Photo by Arsalan Chabok)

3.1.4. Building Materials

Iranian architects attempted to source their materials locally and produce a structure that did not need to be constructed elsewhere and was "enough of itself." As a result, construction work was completed more quickly, the building was "more constructive" with its surroundings, and when refurbished, its structure was always accessible. The Iranian architect considered that the motif's structure should be "boom-brought" or "idri" (here). [Abdollahzadeh, 2010:50] Mazandaran architecture adheres to this guideline, and canvas can be observed in its buildings.

Mazandaran province is split into three broad regions: cold-climate mountainous areas, foothills, and plains. Stone and wood are used in hilly areas, wood is used in forests, and wood and mod are used as the principal building materials on the shore and in the plains. [Kolbadinejad, page 82]

Figure 3-10: A typical house raised on wooden piers with two continuous balconies around and a thatched roof cover in the lowlands of the Gilan Province. (Photo by Maryam Gardoni)

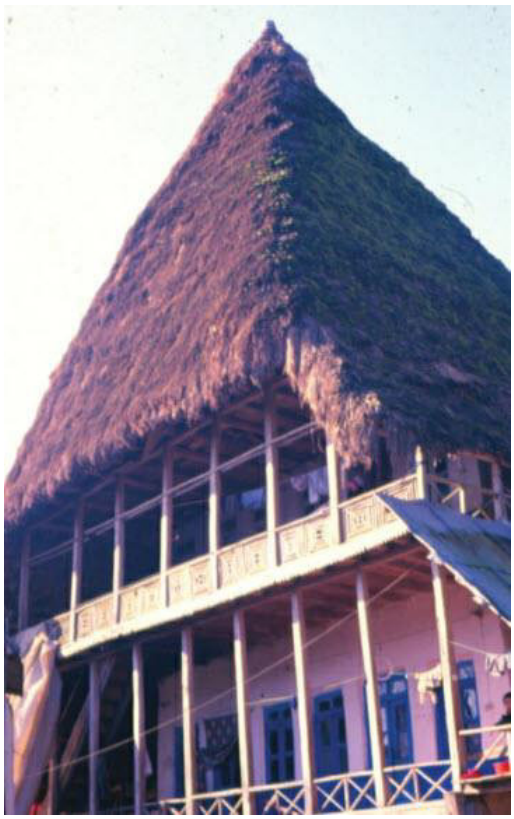


Figure 3-11: A Four-sided pyramid-shaped gable roof of a house near Langarud, in the Gilan Province. Thatch Has been used for covering the roof. (Photo by Vahid Ghobadian)

A. Mountainous area with cold mountainous climate

Stone structures are widespread in Mazandaran's highlands (although they make houses wooden on slopes close to the forest due to the abundance of wood). Stones available in the area are utilized to construct various and essential components of the construction. The foundations are fully composed of stone and mortar mud, and the stone wall is constructed in two ways:

A) flat stone walls with floral mortar in the construction walls

B) flat stone walls without mortar in the enclosure walls (tool steel inserting). [NiaPasha, Yousef, 2006:44]

The roof is flat and coated with dirt and muck. [Sadat Eshkevery, 2000:30]

Figure 3-12: A Stone base house in mountain area with cold mountainous climate.
(Photo by Arsalan Chabok)

B. Plain with a temperate Caspian climate

They were more common in the form of the walls of the stratum, the floor and the ceiling of the wood, as well as the wood as a coil in the wall as a result of the relatively sufficient wood and flowers suitable for the construction of the "woody stratum" houses. This was because the wood and flowers were suitable for the construction of the "woody stratum." Raising the structural resistance is one of the purposes of the stratigraphy. [Yusuf Nia Pasha, 2006 44]

The sloping roof, as well as the 'Gali' (the plant that is used to sit on in pools and ponds), the 'Kolo or kolo' ('stems rice'), the 'Lat Lat' ('little boards')), the 'pottery,' and the fact that it has been the 'attic.' [Sadat Eshkouri ,2000:30]

Figure 3-13: Slopping roof with cover Gali and Pottery (Photo by Arsalan Chabok)

C. Forest Highlands with Caspian Cold Weather

Due to the abundance of woods and trees in this region, practically all buildings are built of wood, including walls, ceilings, floors, and sloping roofs, and wooden houses are widespread in these places. The tree is usually utilized to construct the walls. [Yusuf Nia Pasha,2006:44]

slope roof covered with 'Lett,' 'Pottery,' and, on rare occasions, 'Gali,' and 'Shirvani.'
[Eshkouri, Sadat, 2000]

Clothing is more common in places where rice production is the primary source of income, as well as in communities situated in the center of the forest cover. The 'Lat' coverage from the forest communities has expanded to the plains, and the'stash' coverage has spread with the shift in livelihoods in the forest villages.

3.1.5. Building Sustainable Strategies

A. Porch

In the hierarchy of access from open space, the porch is intermediate and semi-open. The creation of a balcony surrounding the building is the most typical item in urban residences. Even though this balcony allows rooms to interact, it prevents rain from entering the body.

The main porch is the largest room in the home and serves as a living area. This porch is often positioned on the building's eastern or southern side and is higher in elevation than other rooms to take advantage of the nicer scenery and the movement of more air. The porch's many states are as follows. [Gorji Mahlabani, 2010: 137]

The porch's depth is adequate to avoid the sun's harmful sunlight in the summer but does not prevent the sun from utilizing the sun in the winter.

Figure 3-14: A wooden house with porch (Photo available in Wisgoon.com)

B. Ambulatory “Ghulam Gard”

The Ghulam Gard are the areas in front of the halls with two rows of columns. also, to preserve the 'Ghulam Gard' wall, which extends like a porch over the building's environs. [Gorji Mahlabani, 2010:137]

To make a circular passage and its top cover, both walls are covered, a decent area is in the shadow, and the air flow surrounding it can easily pass, allowing occupants to emerge. [Ghobadian, 2006:42]

Figure 3-15: Ambulatory around the second floor in Sari, Mazandaran (Photo by Arsalan Chabok)

C. Sloping roof

Roofs in this region are sloping due to the continual rains. This keeps rain and snow from falling on the building's roof. In these structures, the vacant space between the sloping roof and the roof is an ideal area to store and keep yearly food, and it is designed in such a manner that air and ventilation are accessible.

Figure 3-16: Slopping roof with cover of pottery also opening for ventilation.
(Photo by Arsalan Chabok)

D. Sleeper wall

Roofs in this region are sloping due to the continual rains. This keeps rain and snow from falling on the building's roof. In these structures, the vacant space between the sloping roof and the roof is an ideal area to store and keep yearly food, and it is designed in such a manner that air and ventilation are accessible.

Material and sleeper walls in the temperate Caspian area are a result of topographical circumstances and availability to all types of materials, as well as the experienced knowledge of local artisans, the nature and length of use of the structure, and the economic strength of its constructor. Traditional communication structure

Sleeper wall are classified into four types based on their positioning on the ground:

A. Stone and mud sleeper walls

B. Shakili or Baj Beneh

C. well rock

D. Sleeper wall with construction materials.

The majority of the foundation is built of wood, dirt, and stones.

Under the building, it is either integrated or separate columns. [Kolbadinejad, page 84] Another option observed in certain urban residences is the use of double-walled flooring for the floors of the rooms, so that air movement through the floor wall evaporates moisture and ventilates them.

Figure 3-17: Details of wooden piers under a house near Langarud. (Photo by Vahid Ghobadian)

E. Kutam

As a spring of slumber, a kind of porch and a summer structure known in the Mazandarani dialect are utilized. A four-way independent porch constructed on four long supports is also known as the "shadowed roof."

This is one of the open areas. A chamber with around 3.5 by 5.5-meter proportions erected on wooden gloves or a height of 1.5 to 2 meters above the Earth's surface. This area has four sides open and surrounded with wooden joy. It also features a pyramid-shaped ceiling.

The bottom section of Kotam houses animals, while the higher section houses summer sleep (spring sleep) family people. The building is particularly significant in terms of climate change. Due to the high humidity and heat of the air in the summer that creates the climate in the region, a semi-open space that is open on four sides and away from the ground may be produced by providing a moderate and mild breeze. Blindness may be created in a variety of methods to achieve climatic comfort. [Gorji Mahlabani, 2010:140]

Figure 3-18: Structure of Kutam also use of bottom of it for house of animals. (Photo available in Golvani.ir)

3.2. THE SOUTHERN COASTAL REGION – Hot and Humid Climate

Iran's warmest area runs along the Persian Gulf and the Sea of Oman's shores. It is warm in the winter and hot and humid throughout the summer. "It has an average yearly rainfall of less than twenty cm and a relative humidity of more than 50% all year".

3.2.1. Climatic Conditions

Summers on Iran's southern beaches, which are isolated from the central fault by the Zagros mountains, are very hot and humid.

Winters in these locations are pleasant; summer air temperatures range from 35 to 40 degrees Celsius with high humidity.

Its proportion exceeds 70%. As a consequence, the temperature differential between them has increased.

The air temperature is low at night, during the day, and throughout the seasons. The difference in air temperature between the land surface and the sea surface is significant in these places.

It generates marine and land winds. The sun is shining brightly. This region's cities include Bushehr, Bandar Abbas, Jask, Abadan, and Ahvaz. In general, rainfall along the Persian Gulf coast is more consistent.

The shores of the Oman Sea, which are affected by the monsoon winds of the Indian Ocean, endure irregular and dry showers.

It's been a while. [Kasmaei, 2003: 83-84]

Climate is more essential than the main component and the natural environment in this province, with wind and radiation being the most crucial elements.

The sun is shining. [Aminian and colleagues, 2014: 185]

The following are the climatic conditions of this coastal region:

1. There is little rain, especially in the autumn and winter.

2. Summers are hot and humid; winters are mild.

4. Minimal heat variations between day and night

5. Most underground waters are salty.

6. Lack of flora and trees

Figure 3-19: Courtyard residences with massive wind towers at the Persian Gulf port city of Laft (in the Qesh island). In this hot and humid port city, narrow lanes and palms in courtyards give shade. (Photo by Arsalan Chabok)

3.2.2. Urban Form

Using low-thermal-capacity construction materials and situating the structure in full shadow Wide porches are also covered with a head that keeps rain out while casting a full shadow on the walls of the rooms.

It has been used. Use huge wind deflectors near the water to capture the cool sea breezes. The quantity of natural ventilation is not particularly necessary due to the high heat and humidity of the air, and the fabric of the dwellings is

This is a densely populated region. [Kasmai, 2003, 85-95]

This region has a semi-dense and somewhat open rural texture, with semi-enclosed urban areas and the growth of coastal settlements facing the sea. [Ghobadian, 2009:70] Formalized paraphrase Creating shadows with little penetration

The sun's heat and radiation into the structure, as well as the utilization of natural air movement and the usage of prevailing winds and local breezes

Another thing these locations have in common is that people pay attention to local geography, such as how near they are to bodies of water and vegetation. [Nikghadam,2012:80]

This region's urban fabric featured the following qualities in general:

1.Large cities were built near the sea.

2.Port towns and villages were built along the shore, facing the sea.

3. The urban shape was semi-closed and semi-open.

4.Urban areas and lanes were semi-open, with the majority of them opening onto the sea.

Because the region's economy was based mostly on sea commerce and fishing, and there was no agricultural or industrial development, living near the water was seen as a significant benefit. Another benefit was the weather. The air currents between the land and the sea might travel up to two kilometers into the land. [Watson 1983, 910]

Figure 3-20: Aerial photograph of city of Bushehr. (Google earth)

Figure 3-21: Another view of the port city of Laft with courtyard houses and Water storage (Photo by Arsalan Chabok)

The density and compactness of urban form in this region were something between the temperate climate and the hot and dry climate. This means that it was not as open as in the temperate climates and not as dense or compact as in the hot and dry climate. [Ghobadian ,2009:109]

The fundamental reason for this was that since there were few trees, the urban areas of a sprawling and open urban fabric could not be shielded from sun radiation. As a result, the buildings needed to be close enough together to give shade in the streets and public places.

If the urban fabric was particularly dense, as in a hot and dry environment, there would have been little ventilation, and a heavy and stagnant humid air (relative to dry air) would have settled in and filled the city's confined areas. As a consequence, such a metropolis would have been very unsuitable for human activities.

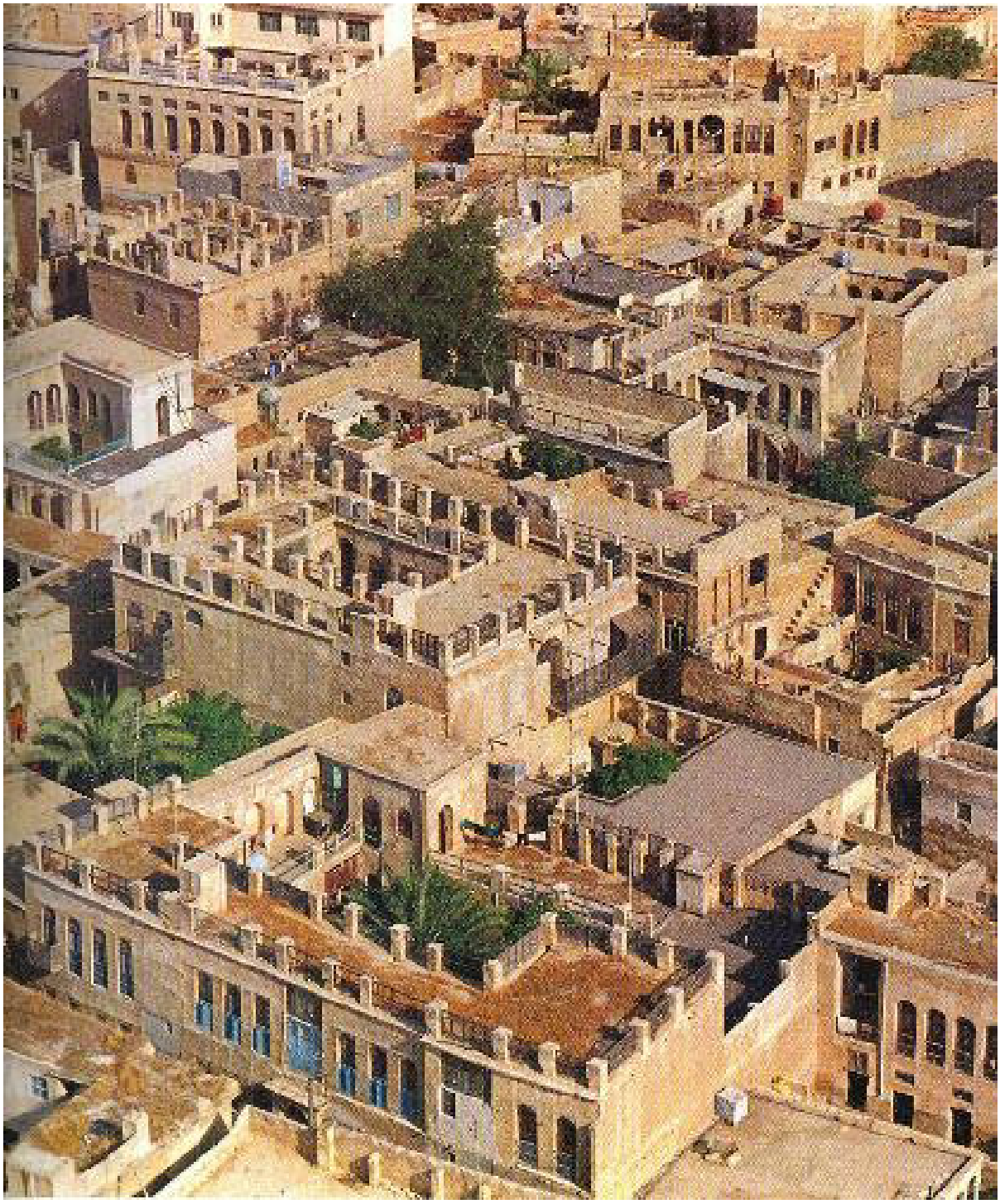


Figure 3-22: Aerial view of the courtyard houses in Bushehr, capital city of the Bushehr Province. Houses have openings both on the inside and outside. Semi urban compactness and flat roofs are the other important features of the old part of this city.
(Photo by Ghazban Poure, 2000, 72)



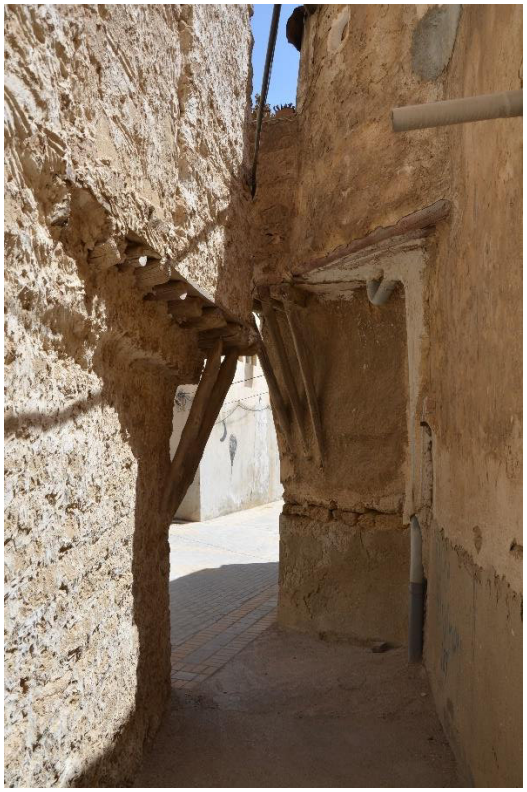



Figure 3-23: The alleys of the old Bushehr are narrow with tall buildings on each side. In this way, shades and sea breezes always exists for the passers. (Photos by Arsalan Chabok)

Figure 3-24: Night view of large Wind towers that receive the circulating wind between sea and land are the dominant feature of the historic port of kong in the Hormozghan Province. (Photo by Arsalan Chabok)

Figure 3-25: Wind towers with different materials in Kong. (Photo by Arsalan Chabok)

Figure 3-26: In order to shade and ventilate inside old houses in Bushehr there were long balconies and high windows all around the courtyards. (Photo by Arsalan Chabok)

Figure 3-27: Renovated hotel in Kong port (Photo by Arsalan Chabok)

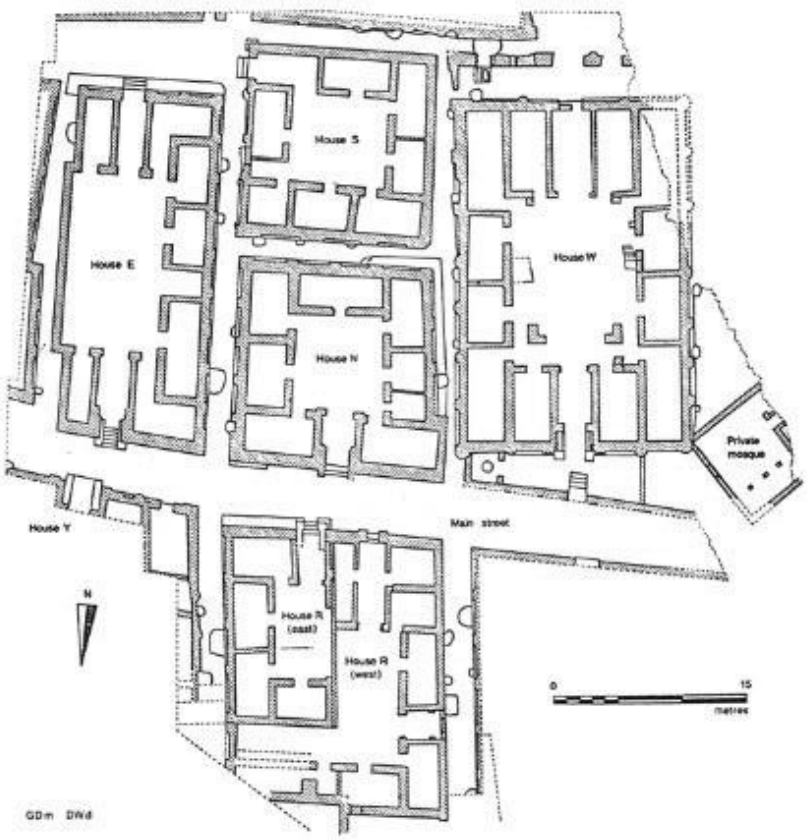


Figure 3-28: In the ancient port of Siraf, there were alleys on all four sides of courtyard houses, so cross ventilation was possible in every room of the building. (Whitehouse, 1972)

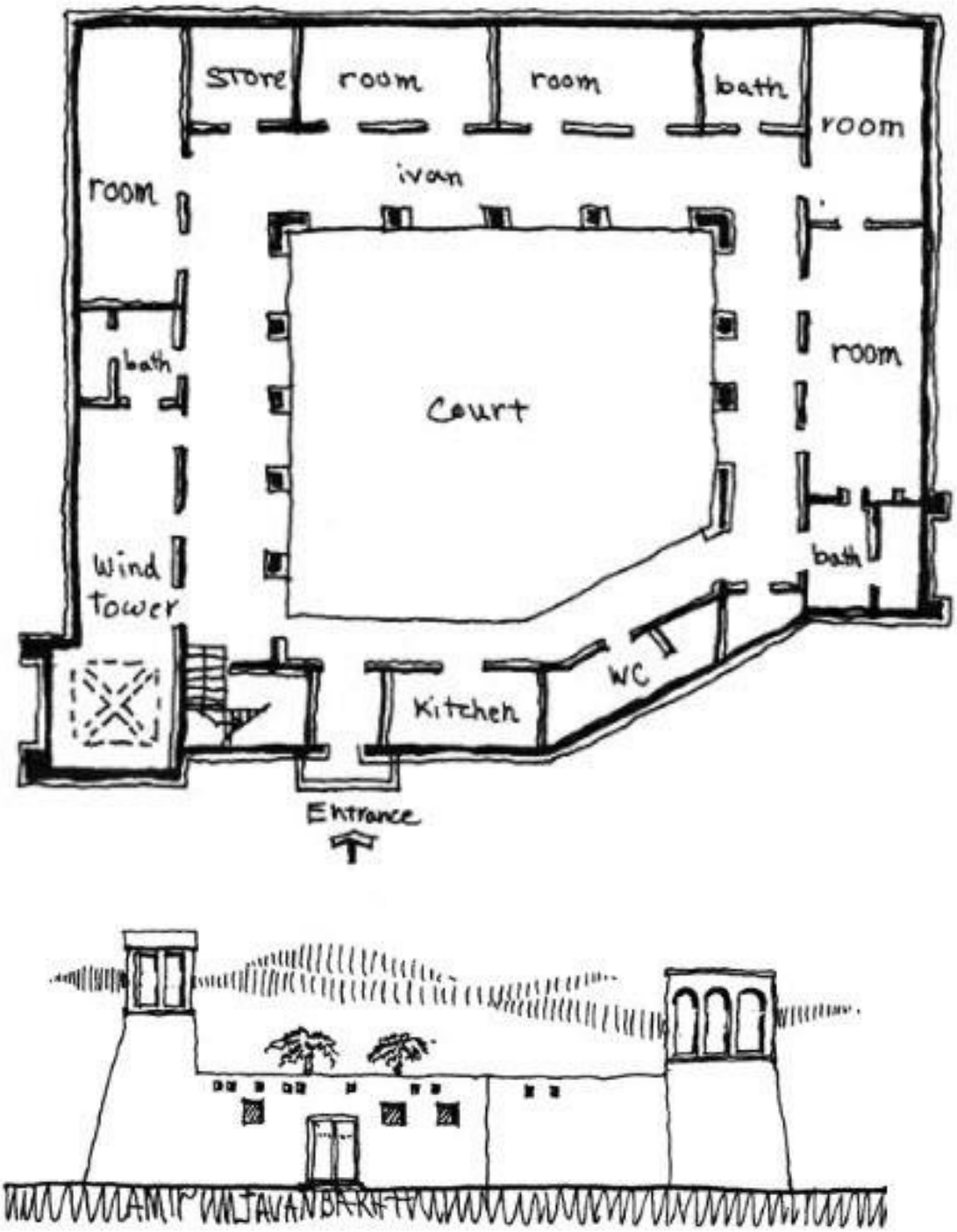


Figure 3-29: Elevations and plan of a courtyard house with a continuous colonnade around the courtyard in the traditional port city of Lengheh. (Bandar Lengeh Master Plan 1966,28)

Figure 3-30: There are large openings around the central courtyard and also on the outside of this house in Bushehr. Therefore, cross Ventilation is always provided inside this building. (Photo by Arsalan Chabok)

3.2.3. Building Form

In a hot and humid environment, the building's design should be stretched, becoming a rectangular cube along the east-west axis.

The building's layout may be free and open if these parts are positioned in complete shadow. And, although huge structures in hot and humid places are more suited if they are freely extended in the direction of the east-west axis, buildings in the direction of the north-south axis are not ideal because they are exposed to intense sunlight. [Kasmai, 2003: 124]

A. When it comes to functions and spatial linkages, it has been discovered that most buildings have a rectangular design and the rooms are three-door and five-door, which caused air conditioning in the past.

B. In this case, the lack of a separating zone (living room) in residential dwellings has resulted in all rooms being immediately linked to the yard.

C. The majority of the rooms are softly lighted, and the majority of the apertures, such as doors and windows, are utilized for ventilation. Located above the windows Grids ornamented with colorful

glass are sometimes visible, and inhabitants utilize them to create light shadows. Plaster, of course, is used nowadays owing to the buildup of insects.

D. Due to the high heat of the air, most windows are narrow and tall, with the passage of air movement taking precedence over light contract.

E. The position of the main windows, particularly in rural regions, is at a height of 20 to 30 cm above the ground because it allows cold air to be drawn in from the bottom portion of the window and hot air to be transmitted from the top part of the window.

F. The ceilings are typically high because hot air travels in the top portion of the room, which should not be there according to human height standards.

G. A sleeper wall is employed in the majority of the structures. This sleeper wall is higher above the yard's level.

H. The length of the structures is largely east-west, with a little north-south thrown in for good measure.

I. The majority of the buildings were constructed with no basements and were elevated around one meter above the ground.

Figure 3-31: Tall opening and top of them color glass with also opening for ventilation
(Photo by Arsalan Chabok)

3.2.3.1. Mashrabiya (shenashil)

It is a balcony facing the exterior of the home and the public road. It is constructed of wood and encircled by mesh fencing

It is covered so that air may circulate freely into it. They may not have a roof in certain circumstances. Shenashil serves various vital roles:

First and foremost, it is a place to relax and enjoy the wonderful wind. You may travel by boat to the residences on the south shore.

The stunning view of the sea (Persian Gulf) was used. Internal halls on one or more stores with views of the yard are constructed. They also serve as a link between distinct areas. The middle grids and various kinds of grids are local linkages between the higher levels.

They allow for several places, but you must travel through the rooms to go from one to the other. In this instance, you may travel through the corridor without visiting the rooms. [Memarian, 2005:94]

Figure 3-32: These wooden louvers, locally called Shanashil in city of Bushehr (Photo by Arsalan Chabok)

3.2.3.2. Wind Towers

The windcatcher is a prominent feature of the architecture of the hot and humid area. A windcatcher is a hose-like ventilator on the roof of a building facing the Persian Gulf that exposes the structure to the comparatively moderate breezes that flow from the tidal sea. A wind enters the home to help cool the hot, humid air. [Pirnia, 2005:332]

In regions near the sea, using a windcatcher

It is common, and the quantity of windcatchers reduces as we walk away from the sea. The wind deflectors for these regions are 3 x 4 meters in size. [Perna, 2009:159]

The four-sided wind towers of this area are much larger than those of the hot and dry environment. Wind towers in the Persian Gulf had a larger cross area but were lower in height.

The reason for this was that they essentially exploited the moderate air currents between the land and the sea. As a result, wind towers had to be large in order to circulate more air; and since dust storms are rare in this location, there was no need to construct them high in order to prevent dust near the ground.

Figure 3-33: Different style of wind tower (Photo by Arsalan Chabok)

Figure 3-34: Increasing magnification of each successive detail of the wind tower (Photo by Arsalan Chabok)

Figure 3-35: Wind tower ceiling detail (Photo by Arsalan Chabok)

3.2.4. Building Materials

Resources utilized in this region include clay, brick, mat, and sedimentary stones. And wood is the greatest material in these locations because it transmits heat slowly and the heat acquired on the surface of the wood throughout the day. Wood distributes heat slowly, and the heat acquired on the surface of the trees throughout the day. There isn't much building going on. As a result, inhabitants are obliged to employ ample construction materials. [Ghobadian, 2009:76]

A.**Architecture with coral and sea sedimentary stones**

Traditional building walls at Bushehr port are made mostly of coral and sedimentary rocks. Because this location was once under water, enormous strata of these stones may be readily obtained and utilized as construction materials in Bushehr, which is several meters deep in the earth. These stones are permeable and serve as excellent heat and sound insulation. [Ghobadian, 2009:82]

Figure 3-36: A house built with coral and sea sedimentary stones in Bushehr city. (Photo by Arsalan Chabok)

B. Stone architecture combined with wood and straw

Flat straw arches are chosen since it is not conventional to create arches and domes on these beaches. This task necessitates the use of wooden beams, which are often constructed of an Indian wood known as (Chandal). First, large wooden beams are put around thirty centimeters apart on two opposing walls. They then put a mat on these beams before covering the roof area with straw. [Ghobadian, 2009:76]

C. Architecture with lumps and plaster stones

Clods and gypsum stones are used to make structures with thick walls, and these stones are coated with thick plaster. The primary function of strong walls in this region is to prevent the entrance of excessive heat and to provide protection from heavy rains. [Shaghaghi and Sharif Khaje Pasha, 2012:7]

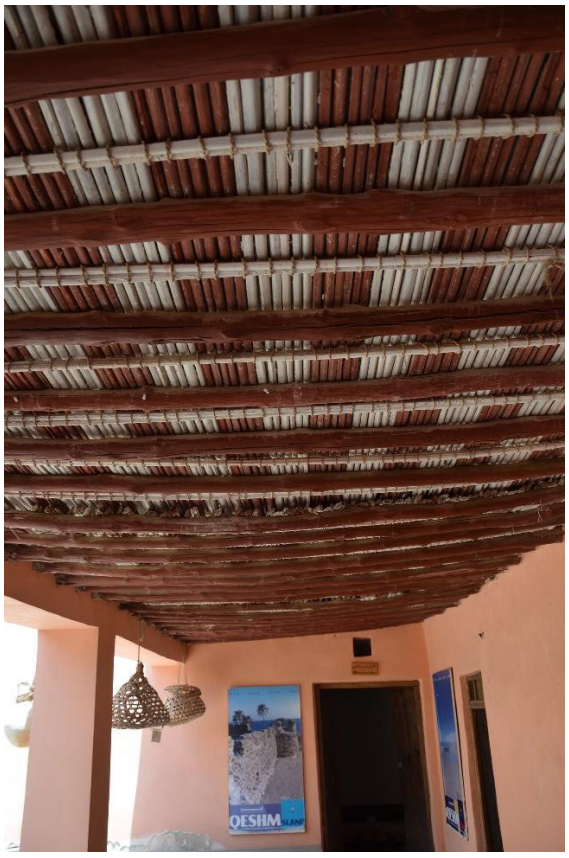
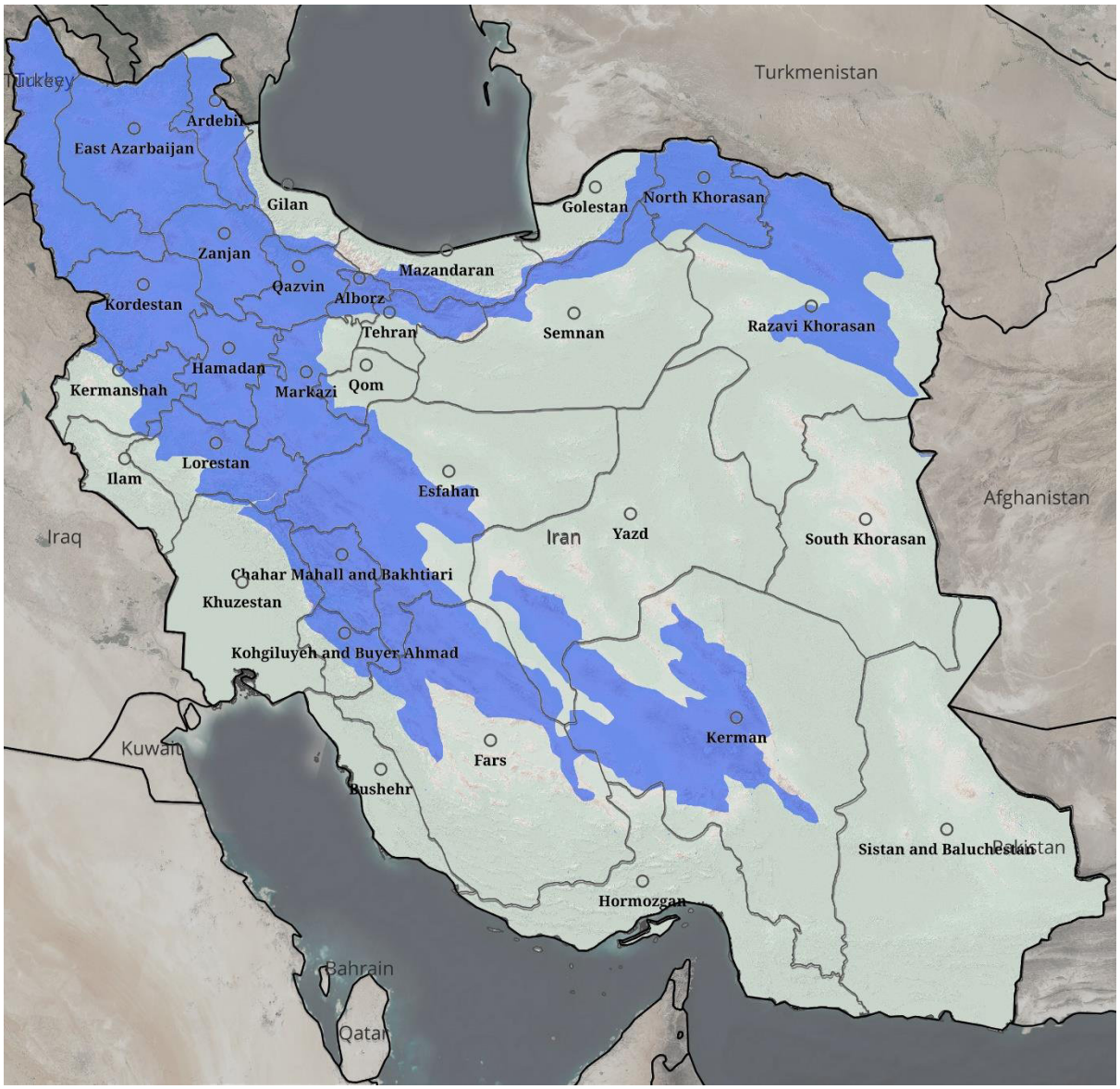


Figure 3-37: The ceiling of a residence in Bandar-e-Kong and Bushehr city is built of palm fronds joined together with ropes. On top of it is a 30centimeter layer of dirt and straw. (Photo by Arsalan Chabok)

3.3. THE MOUNTAINOUS AND HIGH PLATEAU REGION – COLD CLIMATE

The Alborz and Zagros high mountain ranges are located to the north and west of the nation, respectively. This area has an extremely frigid winter and a warm and dry summer. Some of its high summits, such as Damavand and Sabalan, are covered with snow all year. The average yearly precipitation is around thirty millimeters.



3.3.1. Climatic Conditions

The central plateau is divided from the Caspian Sea to the north and formerly ancient Mesopotamia to the west by the Alborz and Zagros Mountain ranges (Figue 1-1). These mountain ranges provide the majority of the water for Iran's major rivers and subterranean water tunnels (qanats).

The following is a list of the climate conditions that are typical of this area:

A. Extremely cold temperatures and wind chills throughout the winter months, particularly in the northwestern region.

B. A significant amount of snowfall, mostly in the northern and northwestern regions.

C. Conditions tend to be pleasant throughout the summer months.

D. Relative humidity tends to be low, particularly during the summer months.

E. Summers see very little precipitation.

F. There is a significant temperature range between day and night.

G. The valleys have high heat in the summer and moderate temperatures in the winter.

Extreme cold in the winter and warm heat in the summer are very different. High night-day temperature differential, significant snowfall, and low air humidity. [Ghobadian, 2009]

Compared to the area in the central plateau, this region receives more rain. Snow covers several of its high mountain summits throughout the year, including Damavand (5671 m), Alam Koh (4850 m), Sabalan (4811 m), and Dena (4435 m). Up to three meters of snow may accumulate in the winter at lower elevations of around 3000 meters, where there are many communities. [Ghobadian,2009]

3.3.2. Urban Fabric

Due to the intense cold for a large portion of the year, these locations have a dense urban fabric and interconnected buildings, which reduces the contact surface between the warm residential rooms and the chilly outside environment. There is a pretty fascinating example of how corridors are referred to in different places. These corridors link most residential neighborhoods to the city's major thoroughfares. They have coverings. [Fazeli, 2012, 114]

The following are some of the primary traits that may be found in the urban and rural fabric of these towns and villages in this region:

A. urban arrangements that are dense and packed closely together

B. Contained areas of the city

C. The orientation of the city fabric toward the winter sun in the south

D. The role that topography plays in the development of urban configuration

E. the cloth and all of its separate parts and pieces

The urban fabric was dense, and spaces were confined. Buildings would lose less heat in the winter this manner, and the spaces would be shielded from cold winds. The allies were typically narrow and occasionally covered by a succession of vaults or tiny domes (like in Hamedan) to defend against cold weather during lengthy winters. [Ghobadian ,2009]

For growth, larger towns and cities need a plateau or a more or less level terrain. As a result, towns like Tabriz (1349 m), Hamedan (1644 m), Shahr-e Kord (2066 m), and northern Tehran (1400 m) sprung up on the southern plains of mountains.

Figure 3-38: This aerial photograph of Tabriz (capital of East Azerbaijan province) vividly shows the city's compact urban structure, enclosed areas, and adjoined courtyard buildings. (Google earth)

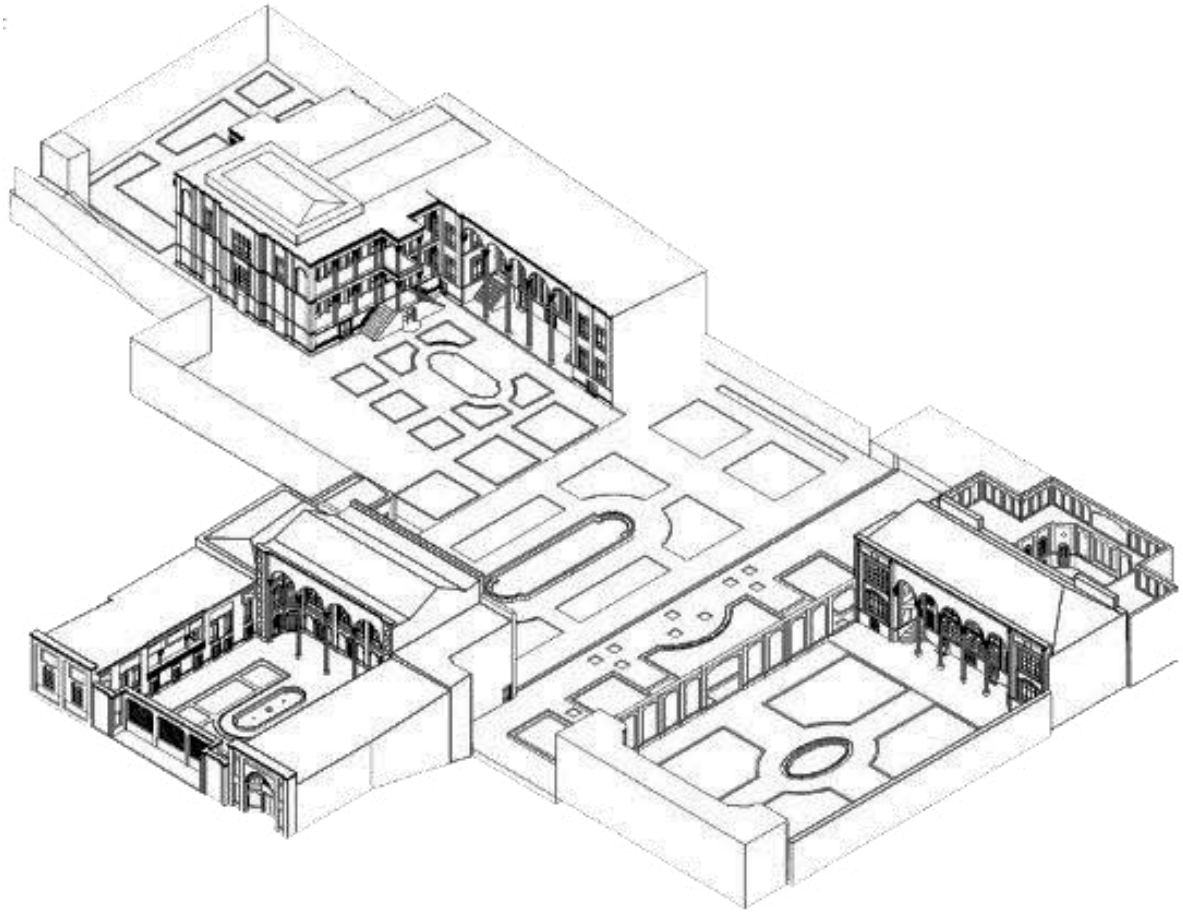


Figure 3-39: Axonometric view from the south-east of three historic homes in Tabriz, from west to east: Ganjehi House, Gadaki House, and Behnam House. It's worth noting that none of them have a summer residence. (Courtesy of National Heritage Organization of Iran)

3.3.3. Building Form

A. The building's shape is intended and executed to withstand severe cold. Buildings in this environment, like those in Iran's central plateau, feature a central courtyard, with other components placed around it. Unlike the temperate and humid southern Caspian Sea coasts, buildings in these places often have basements. [Kasmai,2003]

2. Because the mountainous regions are chilly or extremely cold most of the year, most everyday activities are done in the rooms, thus the yard dimensions in these places are somewhat lower than in the central plateau parts of Iran. Buildings in this environment have porches, although they are substantially shallower than porches in other parts of the nation. Another issue is that in cold areas, the yard floor of buildings is 1 to 1.5 meters below the level of the sidewalks, allowing water to flow in streams and streams. On the one hand, the earth functions as a thermal barrier, restricting heat exchange between the building and its surroundings and retaining heat inside the structure. [Madanipour ,1998]

B. The structures in the cold and mountainous climatic zone have a thick layout and texture. They employ cubes or rectangular cubes in the design of the structure to maintain the ratio of the exterior surface to the internal volume as low as feasible. [Shia ,1378]

C. In cold and snowy places, huge rooms and spaces within buildings should be avoided since increasing their contact surface with the cold outside environment makes heating this enormous space difficult. As a result, rooms in these climates have lower ceilings than comparable ones in other climates. This is done to make the space seem smaller. [Majedi, 2013]

D. In these locations, small holes are employed to limit heat exchange between the interior and exterior of the structure. Openings on the south side are selected to be bigger and more elongated in order to take advantage of as much sunshine as possible; openings facing chilly winds should also be avoided. [Zargar, 1996]

E. As a result of the high diameter of the walls, heat exchange between the inside and outside of the structure is prevented. During the night, the thick walls keep the heat of the day sunshine and serve to regulate the temperature within the structure. The native design of these locations strives to heat the structure as much as possible naturally or with heaters and the heat that comes from people being there. [Shah Hosseini, 2000]

F. Traditional structures on the northern foothills of the Alborz Mountain range feature sloping roofs, although flat roofs are common in hilly places. In a cold region, snow on a flat roof works as insulation against the intense cold. [Zakavot, 1996]

Figure 3-40: Gadaki House in Tabriz has a central courtyard, but no summer area Quarter on the south side. (Photo by Maryam Singery)

Figure 3-41: The Behnam House, like the other two mansions, has been refurbished, and all three now house the Art University of Tabriz. (Photo by Arsalan Chabok)

Figure 3-42: There was usually a basement below the northern side. Because of the coolness of basements in the summer, they were used especially during the summer afternoons (Photo by Arsalan Chabok)

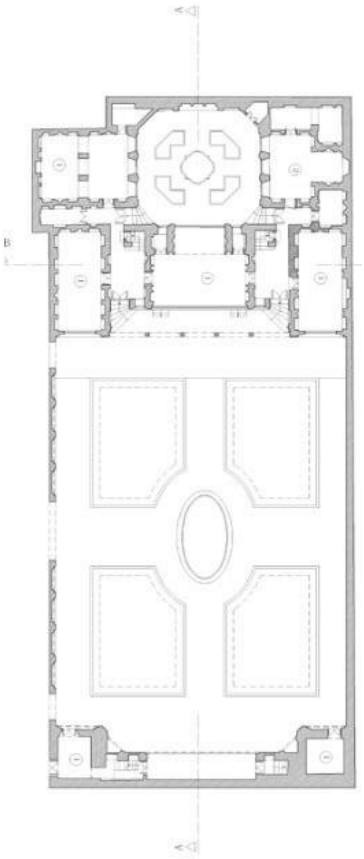


Figure 3-43: First floor plan of the Behnam House

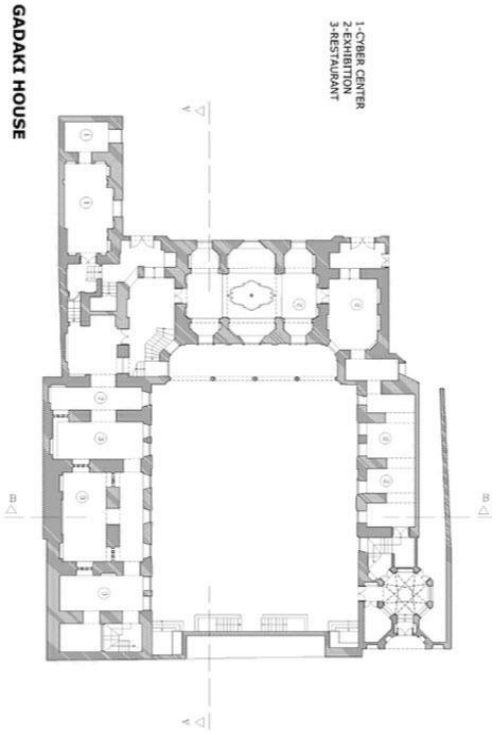


Figure 3-44: First floor plan of the Gadaki House

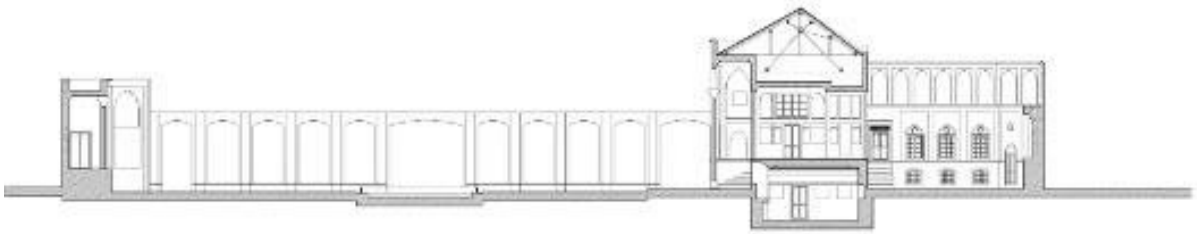


Figure 3-45: North-south cross section of the Behnam House

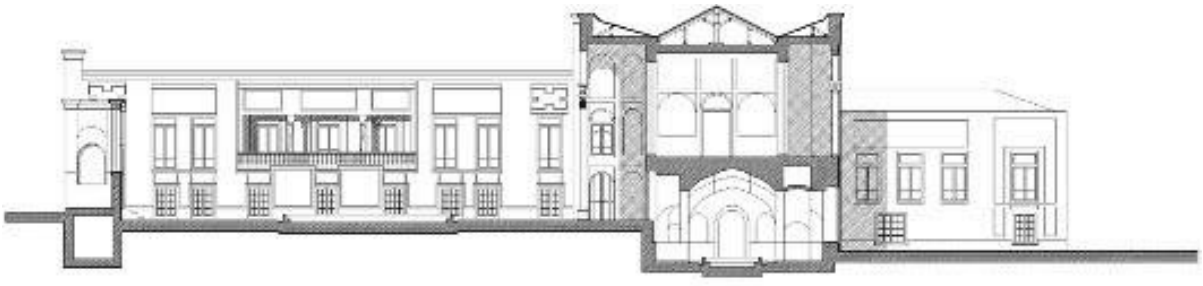


Figure 3-46: North-south cross section of the Gadaki House (Courtesy of National Heritage Organization of Iran)

3.3.4. Building Materials

The traditional buildings in this region utilized materials that were readily available and cost-effective, much like the construction materials used in other areas. The walls were constructed using either rubble or ashlar, and sometimes brick or adobe, depending on what was readily obtainable.

Brick and clay make up the majority of the construction materials, and the walls are often rather thick due to the use of these materials. The walls are often constructed out of brick and clay, and they are rather thick. The roof is covered with thatch. The pillars supporting the roof of the covered porch are constructed out of wood. Plaster is often used to cover these column surfacess.

The only significant distinction between the architectural standards of cold and mountainous climates and hot and dry climates is the location of the heating sources. Heating sources in hot and dry climates are located on the exterior of the building, whereas heating sources in cold climates are located on the interior of the space. As a result, in this environment, the diameter of the walls has to be raised with the assistance of construction materials in order for this wall to be able to operate as a heat storage source inside the structures. In other words, the walls should have a larger thickness.

Figure 3-47: The foundations of the dwellings were composed of stone and brick. (Photo by Arsalan Chabok)

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Figure 3-48: The walls were made of clay. (Photo by Arsalan Chabok)

3.3.5. The Village of Masooleh

The town of Masooleh may be found in the most northwestern section of the Alborz Mountain Range. About eighty kilometers to the southwest of the Caspian Sea is where you'll find this settlement. It's nestled in the foothills of the Talesh Mountain. It is situated at an altitude of 1050 meters and has a latitude of 36 degrees.

Masooleh's architectural design and urban fabric are ecological and environmentally friendly for the following reasons:

A. Building the urban fabric in the center of the foothills in accordance with the region's climatic parameters.

B. Orientation of the city to the south and south-east based on the natural slope of the land owing to the usage of solar heat in Masooleh's cold and snowy winters.

C. Adequate urban texture (mineral stairs). High density and expansion of dwellings at a height with the least amount of land in accordance with the natural slope of the land.

D. The construction of north-south communication channels connecting metropolitan areas based on the earth's natural topography.

E. Building and architecture using native resources such as wood, clay, natural stones, and so on.

F. Designing summer (hall) and winter (third) living areas to be used in various seasons

G. There is no pollution of any kind, including air, noise, or water.

H. Using natural resources such as natural water springs to supply drinking water to people

I. Creating a gently sloping roof to resist precipitation and dampness.

J. It contains thermal insulation to keep the cold out in the winter and moisture insulation to keep rain out.

K. Using natural mountain valleys as sewage disposal conduits in cities

The walls of the buildings at ground floor are made of rubble, which has a good compression capacity and good resistance against rising damp. Upper floors are made with the lighter material of adobe. The roofs are flat and covered with timber, branches and mud and straw mixture. These materials are abundant locally, very economical to use, climatically suitable, and environment friendly and sustainable. [Ghobadian, 2009]

Figure 3-49: Masooleh's main alleys run along to the contour lines of the topography on the rooftops of the buildings below. The secondary alleys follow the contour lines. (Photo by Arsalan Chabok)

Figure 3-50: A broad view of Knadovan, a hilly village in the province of East Azerbaijan. The climate and geography have shaped the settlement's main features. (Photo by Arsalan Chabok)

Figure 3-51: The majority of Masooleh's buildings face south and are shuttered on the other three sides. (Photo by Arsalan Chabok)

Figure 3-52: One corridor in Masooleh crosses another and main market. (Photo by Arsalan Chabok)

3.3.6. The Village of Kandovan

The grades of Lahore and Ignimbrite are known as Kiran or Karan in Kandwan and many other villages in the Sahandabad area. Garan is derived from the ancient word "Karandan," which meaning to injure, throw out, or draw out anything. [Sabri and Islami, 2006, 105] The boundaries were formed in such a way that in the distant past, depending on biological demands and as far as the sort of rocks permitted digging, they were dug out and made into biological areas. [Georji Mahibani and Sanai, 2010:10] The limits may reach a height of fifteen meters and a circumference of eight meters [Ghobadidan, 2009] Borders may be paired, solitary, cone-shaped, or spindly. [Amirkhani et al., 2008, 33] Kandavan village, in general, is developed from the center to the east and from there to the western heights, where production and good circumstances prevail. The eastern boundaries (with a healthier and higher structure) and increased utilization of solar energy (light and heat from the sun) were among the causes for this sort of growth. [Akbari and Bamanian, 2008, 138]

According to polls, the scarcity of natural stones makes it more difficult to extend dwellings. However, according to the standards, the thickness of the walls must be substantial to prevent rocks from breaking, which implies that dwellings cannot be too extended. The lack of natural rocks is responsible for the dwellings' horizontal formation. As a result, as the number of stories increases, the resistance of the rock structure decreases. The construction of structures in this manner is entirely determined by topographical variables. The people of Kandavan hamlet have placed their home doors in such a manner that wild animals and potential attackers cannot enter the residences, compromising security. so that the doors and windows are located more internally.

Figure 3-53: Main view of Kandovan Village. (Photo by Arsalan Chabok)

The chambers that are contained inside the karans are on the smaller side. In most karans, there are one or two rooms, and in other cases there are three rooms. These rooms include a living area, a kitchen, and a space for storing belongings. The dimensions of each room are around 2.5 meters by 3 meters, and the ceiling height is approximately 2.20 meters. On the southern side of each karan, there is a door as well as a couple of tiny windows. The fact that karans have a large thermal mass means that the temperature differences between day and night are reduced, which is a significant benefit in a location like this one. [Ghobadian, 2009]

Figure 3-54: Inside of the rooms and handicraft of the village. (Photo by Arsalan Chabok)

People have lived in these karans for thousands of years, and ownership has been handed down from generation to generation. The only other site like Kandovan is in central Turkey, in the region of Cappadocia.

Figure 3-55: All of the lanes have a severe slant and are made of wood or stone. (Photo by Arsalan Chabok)

Figure 3-56: For ages, inhabitants of Kandovan Village have lived in these cone-shaped rocks as dwellings. The Kandovan Village's benefits include the integration of natural and man-made environments, as well as the high thermal mass of accessible materials. (Photo by Arsalan Chabok)

Figure 3-57: People (on the left) and animals (on the right) have distinct door sizes (Photo by Arsalan Chabok)

Figure 3-58: Animal husbandry is the primary occupation in Kandovan Village. (Photo by Arsalan Chabok)

3.4. THE CENTRAL PLATEAU REGION – Hot and Dry Climate

This is the most extensive climatic zone in terms of surface area, including the majority of the central Iranian plateau. Winters are frigid, while summers are scorching and dry. "Average annual precipitation ranges from 15 to 30 cm, with relative humidity ranging from 20% in the summer to 60% in the winter". This region contains the two enormous central deserts of Kavir Desert and Lut Desert, which account for one-seventh of the country's total area.

3.4.1. Climatic Conditions

One of the factor's influencing architectures is a hot and dry environment. Severe heat in summer, sand storms at periods of the year, wind blowing in various directions, and extreme cold in winter are all climate factors in this water-stressed area. In this context, introversion is the most important predictor of architecture. Harmony with the environment and nature is essential in a hot and dry climate with powerful storms and high heat in summer and harsh cold in winter. Because of the intense sunshine in the summer and the cold in the winter, the building should be positioned towards the south and southeast to obtain greater energy usage during the winter season. In addition, wind deflectors play a vital role in energy management in hot and dry areas. In actuality, the suction is performed by the wind deflectors. [Yasuri, Shamirani, 2018: 54] As a result, there are two components in a hot and dry climate: a shortage of water and high temperatures, and their management is critical in establishing the feasibility of living in these locations.

The climatic conditions in this area are as follows:

A. hot and dry in the summer; cold and dry in the winter.

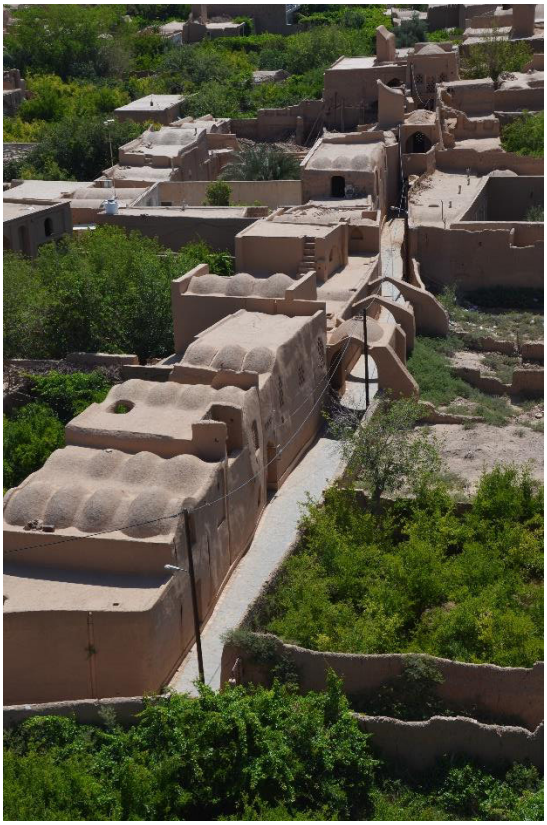
B. little precipitation, particularly in the summer.

C. Low relative humidity, particularly during the summer

D. There is very little vegetation.

E. Extreme temperature swings between day and night

F. Sandstorms in and around the world's two largest deserts



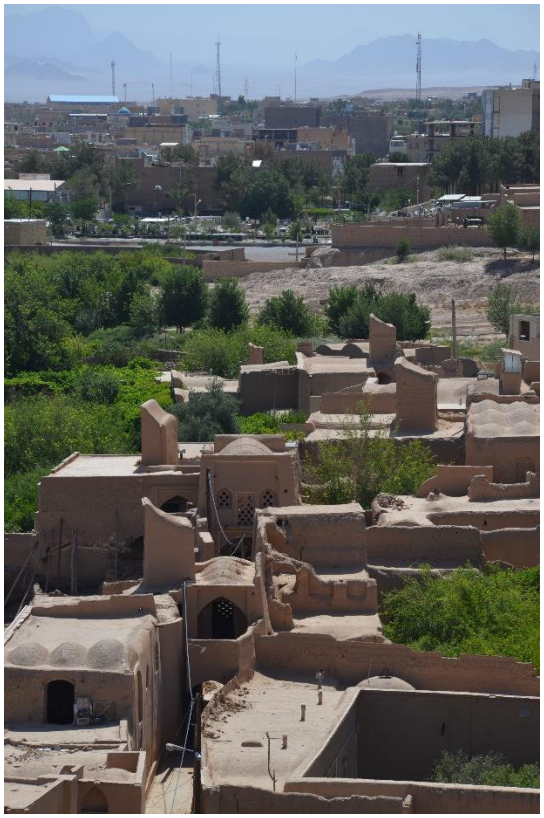


Figure 3-59: Traditional dwellings in Meybod (northern Yazd Province) are entirely enclosed from the outside. The building fabric shields the courtyard's Microclimate from the severe Macroclimate outdoors. (Photo by Arsalan Chabok)

3.4.2. Urban Fabric

Native cities in Iran feature tight and thick structures and textures, and dwellings have interconnecting walls that cannot be differentiated between them. The orientation of the structure is heavily influenced by the overall direction of the city. In a hot and dry region, the major purpose of building orientation is to lower the intensity of the sun in the summer and the daily temperature within the structure. Another objective in the winter is to maximize the strength of the sun, and the north-south orientation is favored. The following are Mamarian's features of introverted houses: [Memarian, 2015: 69] There is no clear visible link between the inner and exterior urban zones. Its areas are designed in such a manner that apertures and openings open onto components such as courtyards or covered screens.

From a typological standpoint, there are two kinds of central courtyards in hot and dry regions; the first type is associated with mansions of the affluent class, while the second type is associated with residences of the middle and lower classes of society. The first kind is huge residences with two central courtyards; the inner courtyard is larger and is known as the insider courtyard, and it is used for intimate lodging. The second smaller courtyard is called outer, and it is made of local materials and adheres to the principles of design by the environment, attempting to deal with the unfavorable and erosive factors of nature, providing comfortable conditions inside the building, and making optimal use of climatic factors. The sun's position, advantageous and unfavorable wind directions, temperature swings throughout the day and night, and availability to water, plants, and appropriate land all played important roles in shaping the earth's structure and features. Perhaps the beneficial characteristics of native house architecture in various parts of Iran can be exploited in the right use of the circumstances considering the climate of the region in the direction of rational cohabitation and productivity with nature. [Ghobadian, 2009:23]

The following were the primary aspects of this region's urban fabric:

A. compactness
B. urban enclosures
C. Narrow and irregular allies, sometimes encased in vaults or domes
D. Related structures
E. The two fundamental considerations for the direction and arrangement of the urban fabric were prevailing winds and sunshine

Figure 3-60: Aerial photograph of city of Yazd. (Google earth)

Figure 3-61: An arial view of courtyard houses and irregular narrow allies in the old quarter of Meybod. (Photo by Arsalan Chabok)

Figure 3-62: view of Yazd city with wind catchers. (Photo by Arsalan Chabok)

Figure 3-63. Narrow streets with semi cover vaults which help air circulation. (Photo by Arsalan Chabok)

3.4.2.1. Qanats

Qanats are subterranean water canals. Water is one of the most pressing issues in this area, and human settlements could not have developed without a steady supply of water.

One of the most effective methods of delivering water was via qanats. These have existed in Iran from the third millennium B.C. [Seyed Sajadi 1982, 14]

Qanats "Kahriz" is a tunnel dug under the earth to allow water to flow through it. An aqueduct is a long-established canal used to manage water in the earth. It is a network of wells that extends thousands of meters from the "Main well." Finally, the water from these canals reaches the earth's surface for drinking and agriculture and settles in a certain location. This new venture was initiated by ancient Iranians many thousand years ago and was known as a qanat or aqueduct. With this technology, which is so far unique in the world, it is possible to gather a substantial volume of subterranean water and bring it to the earth's surface, which, like natural springs, is water all year round without any assistance from the ground to its surface. flow the aqueduct was built by Iranian magnates thousands of years ago. The majority of Iran's aqueducts are over 5,000 years old and have a lifetime comparable to Iran's ancient history. Also, though it has been several thousand years since its conception, this way of utilizing water is still prevalent in many villages and residential, agricultural, and animal husbandry regions across the nation, and it is even one of the key pillars of agriculture in arid places. Forms. This world-famous innovation was eventually taken from Iran to many nations across the globe and is now utilized by people all over the world. The world's longest aqueduct and deepest well are both situated in Gonabad, and its construction goes back to the Achaemenid dynasty or before. Gublo argues that the aqueduct was not originally intended as an irrigation system, but was drawn entirely from mining techniques, and that the goal of its creation was to gather disturbed subsurface water while excavating mines... There is little doubt that mines are "Copper" and maybe "Zinc" located in the Zagros mountains and exploited throughout the second millennium BC in the cultural scope of Iran.

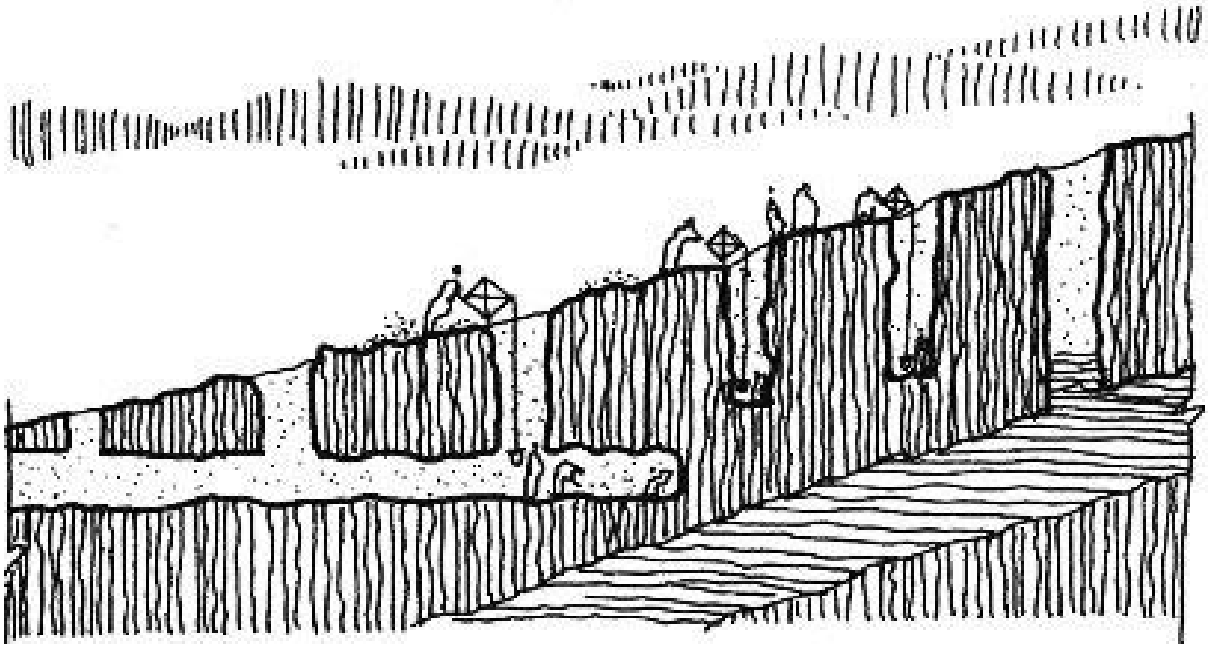


Figure 3-64: Vertical wells are connected with horizontal channels in order to extract more water from the ground for transferring to agricultural fields and population centers. (Sketch by Amir Javanbakht)

Figure 3-65: Photo of Qanats in city of Meybod and still are working. (Photo by Arsalan Chabok)

Figure 3-66: Two types of water collecting from Qanats, water pool to collect(left) and just opening (right). (Photo by Arsalan Chabok)

3.4.3. Building Form

Because of the region's water scarcity, each city neighborhood was assigned a few hours of water for a certain number of days each week. In allies, this water frequently flowed in little open channels. Each home may use a portion of it to water the plants in its courtyard and fill its drinking water cistern. As a result, the ground floors of the structures were lower than the allies', allowing water to be naturally carried into the dwellings by the force of gravity. [Ghobadian,2009]

This region's overall building forms were as follows:

A. Every structure had a central courtyard.

B. The buildings were orientated inward.

C. The majority of the structures had basements, Ivans (verandas), and wind towers.

D. House and courtyard ground floor levels were lower than entry and street levels.

E. Brick or adobe vaults or domes were used to cover the roofs of buildings.

F. High ceilings, particularly on the courtyard's southern side

G. Solid Masonry Walls

3.4.3.1. Central Courtyard

The central courtyard is the key focal point of the dwellings in hot and dry regions, and it is regarded a communal place with an environmental approach. The center courtyard on plots of varying sizes was planned in such a manner that it has a thin and elongated form, providing the essential shade for this area during the hot days. The middle courtyard was constructed to receive sun radiation throughout the harsh winters. This area offered occupants with security, privacy, and comfort. In Godal's central courtyard, there are gardens with various flowers and trees, as well as a shallow pond or pool, which, in addition to being beautiful, also helps to provide comfort to residents by shading and increasing relative humidity, and is an important component of the natural cooling system in these types of houses. [Bonin, 1980:82]

In Yazd and other towns on Iran's central plateau, a big open hall is created in front of the yard where there is most shade, which is generally directly or indirectly linked to the windbreak. Large rooms are positioned behind this hall, with smaller rooms on the other two or three sides of the courtyard. The courtyard floor was laid with square bricks, and it was cleaned with water and a brush, keeping the courtyard cool. As night falls, the warm air in the yard rises and is gradually replaced by the chilly night air in the top section of the yard. The cold air is kept in the thin layers of the courtyard bodies before being delivered to the courtyard's spaces and rooms. The air in the central courtyard gently heats up in the morning and stays frigid until the sun's rays beam straight into the courtyard area. The hot breeze that blows over the house throughout the day does not penetrate the yard and instead causes blind spots. [Dunham, 1960:52]

Figure 3-67: A view of the central courtyard. (Photo by Arsalan Chabok)

3.4.3.2. Openings

Large windows are less often employed in hot and dry areas, particularly if the sun is not kept from entering the interior by shade or suitable construction orientation. Small windows are positioned towards the ceiling and in the top section of the walls. Even if the sun's penetration is totally eliminated or the windows are completely closed, they are still regarded a vulnerability in terms of energy transfer owing to the poor thermal resistance of the windows and the penetration of the sun via the gaps and crevices surrounding them. Only one of the residences in the middle courtyard faces a short lane, while the other faces a nearby wall. This neighborhood might be another plausible reason for the lack of windows in the houses outside walls. The existence of few windows or their disappearance in the exterior walls might be attributed to the desire to maintain the family's privacy. Few windows have been found in the exterior walls of buildings in the Islamic era, however the concept of safeguarding women as a purpose in this construction may not be entirely right. [Bonin, 1980:199]

Figure 3-68: A view of the central and all the openings are open inside the courtyard. (Photo by Arsalan Chabok)

3.4.3.3. Ceilings and Vaults

Introverted buildings with a central courtyard have a tiny parapet wall that is slightly higher than the sight level and covers the edge of the roof. This parapet not only gives privacy and security for sleeping and sitting at night, but it also protects and provides thermal comfort for the home. The Cairo Building Research Center tested thermal comfort in two separate structures in 1964: one with 50 cm thick brick walls and a roof that was a hybrid of a dome and a vault, and the other with walls and a roof composed of 10 cm thick Precast concrete panels. This test revealed that although the internal air temperature in a structure with a domed roof stays in the comfort zone, the indoor air temperature in a building with a precast concrete roof is even higher than the building's external air temperature. [Bonin, 1980:206]

Figure 3-69: Different types of ceiling in city of Meybod. (Photo by Arsalan Chabok)

In a hot and arid environment, a flat roof is paved with square bricks known as "Farshi." During the day, these bricks get the greatest solar radiation, and the temperature rises in the early morning and falls in the late evening. And this motion alters both the strength and angle of the sun's radiation. The roof is more exposed to the sun's light and the heat it generates than the house's walls. Choosing a dome shape to cover a building's roof has thermophysical as well as structural implications. The vault's hemispherical cover has a convex and non-uniform surface that, because to its curved surface, moderates the sun's radiation in various directions at different times of the day, lowering the warmth of the roof. The angle of contact of the sun's rays on the dome and vaulted ceilings varies from one place to another, and a portion of its surface is shaded in the morning and evening. [Haji Ghasemi, 2013: 70]. As a result, the curved shape for the emission and release of the sun's waves and radiation is appropriate at night and aids in cooling. The roof of a structure in a hot and dry region has the highest surface area exposed to sunlight and so releases the most energy. Conduction and transmission of heat are done slowly and with a delay in buildings made of heavy materials, and the daily heating condition is maintained balanced. [Fathi, 1993: 49]

Figure 3-70: Dom style of ceilings and one-side open windcatcher in Meybod. (Photo by Arsalan Chabok)

In Iran, three types of vaults were commonly used:

A. The simplest form is the barrel or tunnel vault, which looks like an extended arch.

"The Sassanian dynasty's outstanding royal monument of Taq-e Kasra at Ctesiphon, now in present-day Iraq, is the best and largest example of such a vault." Shapoor I most likely built it in the second half of the third century, and the portion that remains rises above the plain like a grey cliff. Its Ivan (veranda), a great open vault 75 feet wide - wider than any vault in Europe - is 90 feet high and nearly 150 feet deep." [Pope ,1976]

B. The groined vault is made when two-barrel vaults cross at right angles. The greatest examples of this kind of vault may be seen in Esfahan's winter worshipping hall of the Friday Mosque and the lower portion of the Khajoo Bridge. [Ghobadian, 2009]

C. Four ribs are initially built for a form of vault called as Kolumbeh. For this sort of vault, the filling that created the four pendentives - between the four ribs- would be repeated until the whole area was covered.




Figure 3-71: Different types of vaults. (Photo by Arsalan Chabok)

3.4.3.4. Four Season Houses

In traditional structures, particularly traditional homes, it was essential to align daily activities and routines with the local climate to ensure a comfortable living environment. Houses designed for all seasons were a prime example of this approach.

During the winter, the family would reside in the northern portion of the house that received direct sunlight and warmth through the central courtyard. In the hot months, the southern section of the house, which was always shaded, was utilized. Wind catchers were installed on this side of the house, making it cooler and more livable during summer. There was often a basement beneath this area, and the wind catcher shafts were connected to it. When the ground floor became too hot, especially during summer afternoons, the occupants would move to the basement for comfort. [Ghobadian,2009]

Figure 3-72: Four season houses winter area in front and fall and spring in sides.

(Photo by Arsalan Chabok)

The central courtyard's plants, trees, pool, and fountain would humidify and cool the area, creating a comfortable microclimate. The courtyard was shielded from the harsh and dry macroclimate of the outside world by the walls and rooms that surrounded it.

Figure 3-73: Summer building where is open and have windcatcher on top(left) and fall and spring area in two side (right). (Photo by Arsalan Chabok)

3.4.3.5. Wind catcher

A wind catcher is a component of the structure of buildings in hot and arid parts of Iran that, by directing wind flow and using natural energy, has played a successful role in changing temperature and bringing the temperature of the living space to human comfort. [Mahmodi, 2017] They have also been utilized to move outside air into residential spaces and suction air from within to outside to assist maintain thermal comfort in the summer. [Bahadori, 1977] It is caused by the decaying of the reservoir water. Pleasant wind enters the wind deflector from one direction, and pleasant air enters and escapes in that direction against the wind owing to negative pressure and suction of the warm air within. In addition, certain recesses or treasures had wooden doors to regulate the wind, which functioned like today's freezers. [Naibi, 2002]

In Iran, there were three kinds of wind towers: one-sided, four-sided, and eight-sided wind catcher.

A. One-sided

Near the deserts, one-sided wind catchers were constructed. Their apertures were designed to face the cool summer breezes of the more favorable sections, rather than the desert dusty winds. Many of these wind catchers may still be seen in towns like as Maybod, Ardakan, Bam, Aghda, and southern Khorasan Province. [Ghobadian, 2009]

Figure 3-74: One-sided wind towers protruding from buildings in the city of Meybod near Yazd in central Iran. (Photo by Arsalan Chabok)

B. Four-sided

The most prevalent kind was wind catchers. Most cities in this area, including Tehran, Esfahan, Shiraz, Kerman, Kashan, and Yazd, used to have them. Many are still in use. Dusty breezes were uncommon in these towns, and they could pull wind from any direction, which is why four-sided wind catchers were suitable.

Figure 3-75: Four-sided wind tower takes in wind from one side and let air out form the other side.

(Photo by Arsalan Chabok)

Figure 3-76: Four-sided wind catcher, different style with different size depends on usage.

(Photo by Arsalan Chabok)

Figure 3-77: Wind catchers in night. (Photo by Arsalan Chabok)

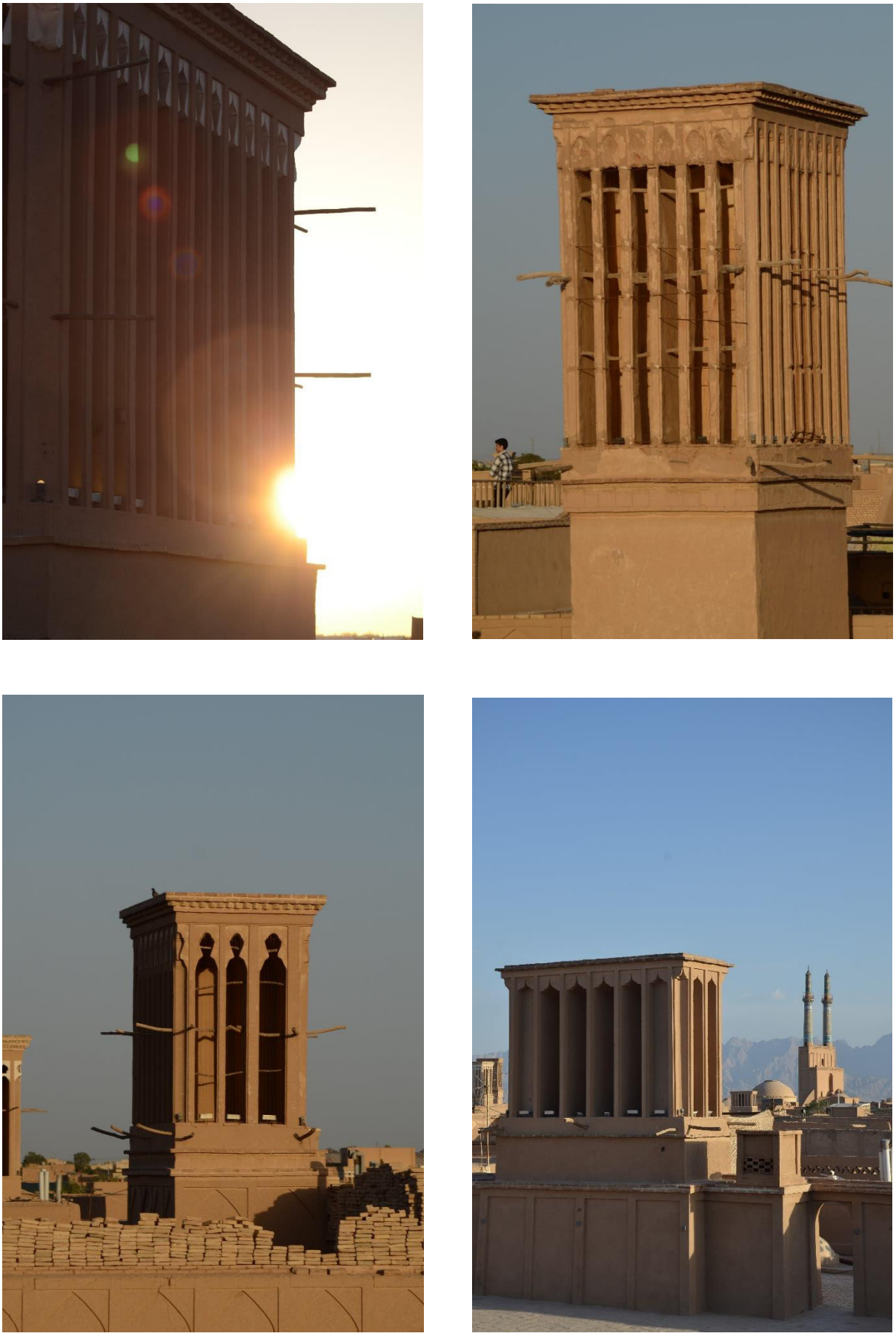


Figure 3-78: Different styles four-sided wind catcher with different ages. (Photo by Arsalan Chabok)

C. Eight-sided

This sort of wind catcher has a superior capacity to accept wind since it can enter from whatever direction the wind is blowing. This sort of wind catcher is often found above water reservoirs, and the only one found in Yazd residential structures is Dolatabad Garden. Yazd is home to the world's highest wind catcher. It may be found at the Dolatabad Garden. It is 33 meters tall and has an evaporative cooling pool and fountain underneath it.

Figure 3-79: The eight-sided wind catcher of the Dolat-Abad Garden in the city of Yazd is 33 meters high, making it the tallest wind catcher in the world.

(Photo by Arsalan Chabok)

Figure 3-80: Plan of eight-sided wind catcher. (Photo by Arsalan Chabok)

3.4.4. Building Materials

Local structures were usually constructed using readily accessible resources. Mud was often utilized to create walls in hot and arid locations. Stone, brick, and clay were also used to construct enormous walls.

Mud is damp dirt combined with water and tiny particles of straw that is used to construct mud walls. The low heat conduction coefficient of clay indicates that it has a higher thermal coefficient than baked brick or concrete. One of its significant disadvantages is its vulnerability to rain and earthquakes. Clay is made up of dirt, water, and sometimes microscopic bits of straw. This composition is laid on the ground and dried in the sun after being created in square wooden molds. Clay is used to construct thick walls. Buildings have also been constructed using a blend of raw clay and baked brick. The same baked clay that has been reduced in size owing to the heat of the fire is used to make brick. Bricks are used to build floors and walls. Because bricks are less expensive than stone, they are often used to pave the center courtyard. To guard against atmospheric conditions, the roofs are additionally "bricked." Coarse and rough stones are utilized as the sole accessible construction materials in places near mountains and even in the desert. Stone is used to construct swimming pools, ponds, staircases, sidewalk tables, yard wall plinths, and other areas where cracks and fractures are possible. The inside half of the walls and ceilings are normally plastered, while the exterior section is coated with a mixture of clay, water, and straw particles. The addition of straw to this mixture makes it flexible and sturdy. In areas of the structure that are susceptible to moisture, lime is sometimes added to this mixture. Plaster, when applied on a rough texture, transforms it into a smooth surface that is highly appealing when golden straw-colored bits are visible on it. In hot and dry conditions, the thermophysical characteristics of these materials are critical. These materials have great heat capacity and thermal resilience, and they absorb sunlight via their exterior surfaces. Three elements contribute to these significant characteristics. [Haji Ghasemi, 2013:19]

Figure 3-81: tiny particles of straw which use in mud walls. (Photo by Arsalan Chabok)

Figure 3-82: Mud walls are made of moist earth mixed with water and microscopic particles of straw. (Photo by Arsalan Chabok)

Figure 3-83: Clay is composed of dirt, water, and sometimes small particles of straw. (Photo by Arsalan Chabok)

Figure 3-84: Bricks are used to build floors and walls as a base and upper level is clay. (Photo by Arsalan Chabok)

The great intensity of the sun's radiation boosts solar energy absorption via exterior surfaces. With limited ventilation, the temperature in this environment rises to 27-28 degrees Celsius due to the low vapor pressure. Only with modest ventilation throughout the warmer hours of the day is the inside temperature maintained lower than the external temperature. Lowering the internal temperature is dependent on the consistency of the pleasant heat period. This phenomenon is noticed under the ground of Yazd dwellings, where inhabitants take afternoon naps. In a hot and dry climate, the average daily temperature of the outside air, combined with the best daily ventilation pattern, ensures the stability of pleasant heat in the building and keeps the daily temperature of the interior constant and below the high temperature of the exterior. [Haji Ghasemi, 2013: 32]

Figure 3-85: Mud wall which cover the clay. (Photo by Arsalan Chabok)

Figure 3-86: Taper wall made of clay in Meybod (Top left) use wood to keep the weight of the building (top right) not cooked brick (bottom left) cooked brick (bottom right). (Photo by Arsalan Chabok)

CHAPTER 4

GIS ANALYSIS OF YAZD CITY

YAZD GEOGRAPHICAL INFORMATION

Yazd, often written Yezd, is a city in central Iran that serves as the capital of the Yazd province. Marco Polo characterized the city as the "great city of Yazd" in the fifth century CE. It is located on a mainly desolate sand plain about 4,000 feet (1,200 meters) above sea level. The weather is entirely desertic. A network of qanats (water tunnels) connects Yazd to the edge of the adjacent mountain Shir Koh. Yazd was historically the link between Fars and Khorasan, as well as between Persian Iraq and Kerman, and it was located at the crossroads of trade routes between Central Asia and India. [Britannica, T. Editors of Encyclopedia (2019, January 23). Yazd] Yazd is a city located in central Iran, known for its rich history, cultural heritage and stunning architecture. As a result of its unique geographical location and climate, the city has become a subject of interest for geospatial analysis. This analysis is aimed at understanding the environmental and cultural factors that have contributed to the development of this city, and its impact on the region. The analysis is based on data obtained from the National Cartography Center, and uses the WGS 84/UTM Zone 39N coordinate system. This system provides accurate and reliable information about the location and geographic features of the city. The data obtained from this source allows for a comprehensive analysis of the city's physical, cultural, and demographic characteristics. One of the four main climates that will be analyzed is the hot and dry climate, which is prevalent in the region around Yazd. This climate has a significant impact on the city's water resources, agriculture, and human settlement patterns. The analysis will also explore the ways in which the local residents have adapted to this challenging environment, and the impact it has had on their daily lives.

In conclusion, the geospatial analysis of the city of Yazd will provide a comprehensive understanding of its unique physical, cultural, and demographic characteristics. The data obtained from the National Cartography Center and the use of the WGS 84/UTM Zone 39N coordinate system, will provide a solid foundation for this analysis, and allow for a more in-depth understanding of the city's development and its impact on the region

650000 700000 750000 800000 850000 900000 950000 1000000 1050000 1100000 1150000 1200000

3700000 3650000 3600000 3550000 3500000 3450000 3400000 3350000 3300000

ELEVATION ANALYSIS OF YAZD

This map shows, elevation and is we can see the most of the land is flat and just Taft city have mountain and also the capital of the region(Yazd) is in the valley .
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10m
Spatial Scale 1:10000
Map Scale 1:1500000

Ardakan
Bahabad
Ashkezar
Yazd
Meybod
Bafq
Taft
Mehriz
Abarkuh
Harat

LEGEND

ELEVATION (m)
Band 1

- <= 714
- 714 - 1500
- 1500 - 1900
- 1900 - 2200
- 2200 - 2600
- 2600 - 2900
- 2900 - 3200
- > 3200

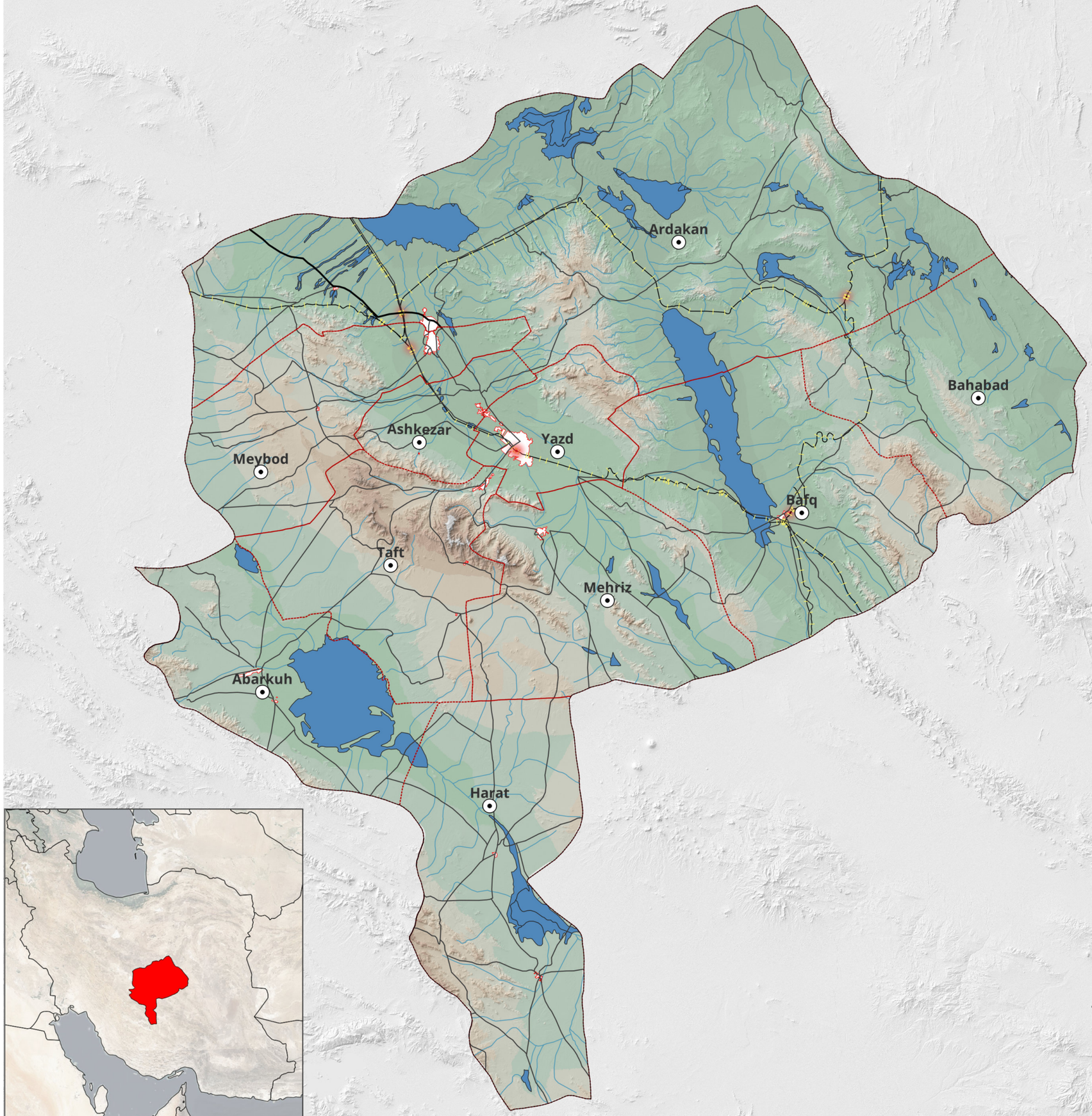
NATIONAL CARTOGRAPHIC CENTER
www.ncc.gov.ir

MAP SCALE 1:1500000

0 25 50 75 100 km

ACCESSIBILITY AND ELEVATION, LAKES,RIVERS ANALYSIS OF YAZD

This map shows, Accessibility and cities connection analysis, as we can see there is no permanent rivers and lakes .
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10m
Spatial Scale 1:10000
Map Scale 1:1500000



LEGEND

REGION BOUNDARY

URBAN BOUNDARY

ELEVATION (m)
Band 1

<= 979

979 - 1245

1245 - 1510

1510 - 1776

1776 - 2041

2041 - 2307

2307 - 2572

2572 - 2838

2838 - 3103

3103 - 3369

> 3369

LAKES
Intermittent

RIVERS
Intermittent

ROADS
Primary Route
Secondary Route

RAILWAYS
platform
rail

NATIONAL CARTOGRAPHIC CENTER
www.ncc.gov.ir

MAP SCALE 1:1500000

0 25 50 75 100 km

POPULATION ANALYSIS OF YAZD

This map shows, The population of each city and as we understand the capital of the region (Yazd) is the most populated city of the region.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10M
Map Scale 1:1500000

Ardakan
Meybod
Ashkezar
Yazd
Bahabad
Bafq
Taft
Mehriz
Abarkuh
Abarkuh
Khatam
Khatam

LEGEND

POPULATION (P)
656474
99727
97960
51733
51552
50845
43893
36562
32566
17221

LAKES
Intermittent

RIVERS
Intermittent

URBAN AREAS

NATIONAL CARTOGRAPHIC CENTER
www.ncc.gov.ir

MAP SCALE 1:1500000

0 25 50 75 100 km

BASIN, RIVERS AND LAKES OF YAZD

This map shows, Different basins and situation of rivers and lakes of Yazd.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10M
Map Scale 1:1500000

Ardakan
Meybod
Ashkezar
Yazd
Bahabad
Bafq
Taft
Mehriz
Abarkuh
Abarkuh
Khatam
Khatam

LEGEND

BASIN
- Abar qo-Sirjan
- Tashk-Bakhtegan-Maha
- Daranjir desert
- Black mountain desert
- Lut Desert
- central desert
- Gavkhouni

LAKES
- Intermittent

RIVERS
- Intermittent

REGION BOUNDARY

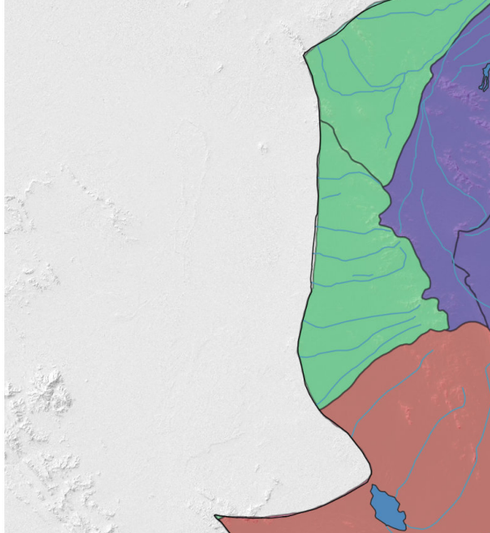
NATIONAL CARTOGRAPHIC CENTER
www.ncc.gov.ir

MAP SCALE 1:1500000

0 25 50 75 100 km

BASIN SITUATION OF YAZD

This map shows, Basin situation in region of Yazd and as we can see divided by three: Free(unrestricted), Forbidden(prohibited), critical ban(severe restriction). The most of main cities are built in critical banned and the situation of basin is super bad but forbidden is better than critical but in danger of Drought.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10m
Map Scale 1:1500000



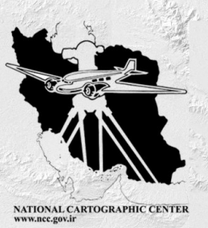
LEGEND

BASIN SITUATION
- free
- forbidden
- Critical ban

LAKES
- Intermittent

RIVERS
- Intermittent

URBAN AREAS



NATIONAL CARTOGRAPHIC CENTER
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MAP SCALE 1:1500000

0 25 50 75 100 km

LAND USE OF YAZD

This map shows, Land use and is we can see the most of the region is bare land and poor range.
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10M
Map Scale 1:1500000

LEGEND

landuse

- Agriculture
- Agriculture_Dry-Farming
- Agriculture_Garden
- Dense Forest
- Forest
- Forest_Sanddune
- Forest_Wood-Lands
- Low Dense Forest
- Moderate Dense Forest
- Wood-Lands
- Bare Lands
- Garden
- Dry-Farming
- Garden_useless
- Good Range
- Moderate Range
- Poor Range
- Rock
- Rock_Bare Lands
- Rock_Poor Range
- Aquifer (Abkhan)
- Fishery Pool
- island
- shoreline
- Water-Lakes
- wetland
- Wetlands
- Desert
- Mangro
- Masil
- Mixture
- saltlake
- Salt Lands
- Sanddune
- Urban

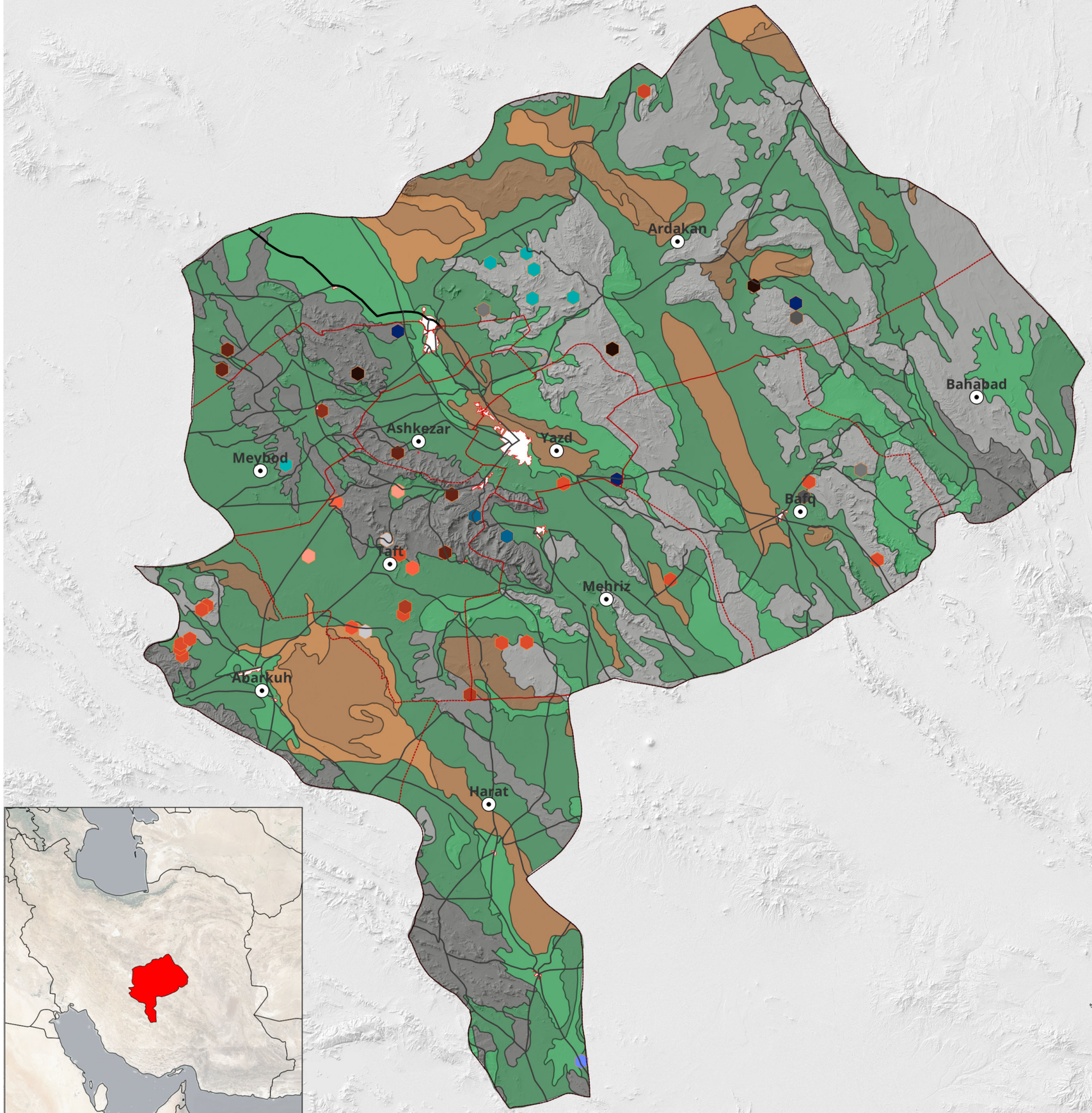
NATIONAL CARTOGRAPHIC CENTER
www.ncc.gov.ir

MAP SCALE 1:1500000

0 25 50 75 100 km

MINES AND SOIL ANALYSIS OF YAZD

This map shows, Soil analysis and mines sites of Yazd region, as understand this region is very rich in resources and is good for building material .
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10m
Spatial Scale 1:10000
Map Scale 1:1500000



LEGEND

MINES

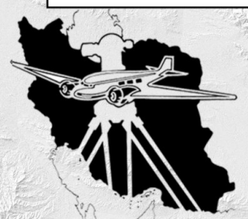
- Barite
- Granite
- Hematite
- Huntite
- Lime Stone
- Marble
- Salt
- Travertine & Marble
- Travertine
- Building Stone
- Crystaline Lime Stone
- Fire Clay&Industral Clay
- Industrial Clay
- Gypsum
- Iron Stone
- Lead & Zinc
- Polymetal
- Copper

ROADS

- Primary Route
- Secondary Route
- URBAN BOUNDARY
- REGION BOUNDARY

SOIL ANALYSIS

- Unusable Lands
- Dune Lands
- Playa
- Salt Flats
- Rock Outcrops/Entisols
- Rock Outcrops/Inceptisols
- Rocky Lands
- Aridisols
- Entisols



NATIONAL CARTOGRAPHIC CENTER
www.ncc.gov.ir

MAP SCALE 1:1500000

0 25 50 75 100 km

CLIMATE ANALYSIS OF YAZD

This map shows, Climate analysis of Yazd region, as we can see the most of region is hot-dry and hot-super dry .
Coordinate Reference System: WGS 84 / UTM zone 39N
Cell Size:30X30
Spatial Resolution: 10m
Spatial Scale 1:10000
Map Scale 1:1500000

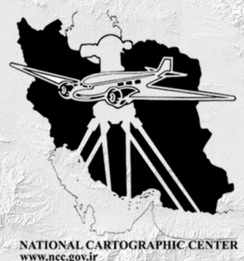
LEGEND

REGION BOUNDARY
URBAN BOUNDARY

CLIMATOLOGY

Super Dry
Dry
Semi-Dry
Medium Semi-Dry
Super Semi-Dry

Ardakan
Bahabad
Ashkezar
Yazd
Meybod
Bafq
Taft
Mehriz
Abarkuh
Harat



NATIONAL CARTOGRAPHIC CENTER
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MAP SCALE 1:1500000

0 25 50 75 100 km

CHAPTER 5

OUTCOME AND RECOMENDATIONS

5.1. Traditional Buildings Aspect

structures were four-sided gable roofs. To allow the winter light to enter through the southern openings, the gable roofs or canopies were kept relatively low. In the hot and arid central plateau region, homes were inward-facing with central courtyards to protect from frequent sand storms. All doors and windows, except for the main entrance, opened to one or more courtyards, and the northern wing, which received direct sunlight, was used for living quarters in the cold months, while the southern wing, in constant shadow, was used in the summer. Wind towers were often built over the summer wing to provide additional cooling. In the frigid mountain settlements, homes were usually oriented towards the south to take advantage of the sunlight, with soil or adjacent buildings providing protection from heat loss. These dwellings, like those in the central plateau, were inward-facing around a central courtyard. The main difference was that the winter dwelling quarters were larger and more significant in the mountain settlements. In the hot and humid area near the Persian Gulf and Sea of Oman, central courtyard homes were also popular, with both interior and exterior openings to allow for cross ventilation. Balconies, large openings facing the sea breeze, and wind towers provided shade and cross ventilation. In the semi-humid subregion near the Persian Gulf, homes were also semi inward facing for internal cross ventilation, with larger summer quarters. Traditional buildings in Iran varied in shape depending on the climatic conditions, and architectural form was often dictated by climate, as seen in the diagrammatic illustrations of typical homes in different climatic zones.

5.1.1. THE NORTHERN COASTAL REGION - TEMPERATE CLIMATE

Climate conditions	1. Heavy rainfall, particularly in the autumn and spring, and snowfall in the winter 2. Consistently high relative humidity throughout the year 3. There aren't many temperature differences between day and night. 4. Winters are cold, while summers are hot and humid. 5. entirely covered with trees and plants
Urban and sub-urban fabric	1. Open urban areas on each side 2. Buildings were dismantled 3. The streets were broad and open on both sides. 4. Seaside towns dotted the shoreline. In this manner, the sea breezes were used to keep people cool.
Building strategies	1. Detached structures 2. Four-sided gable roofs, especially for dwellings 3. Buildings that face outward 4. A long, continuous balcony that encircled the home on all sides. 5. Gable roof extension over the balcony 6. There is no basement. 7. The ground floors of the buildings were one to two meters higher than the surrounding ground.
Materials	1. Wood 2. Masonry 3. Plant material

5.1.2. THE SOUTHERN COASTRAL REGION - HOT AND HUMID CLIMATE

Climate conditions	1. There is little rainfall, primarily in the autumn and winter. 2. Hot and humid in the summer 3. Mild in the winter 4. Low thermal changes between day and night 5. Most localities have salty subsurface waters. 6. The scarcity of trees and vegetation
Urban and sub-urban fabric	1. Major cities were built near the sea. 2. Port towns and villages were oriented toward the sea and were distributed along the coastline. 3. The urban shape was both dense and open. 4. The urban areas and lanes were semi-open, with the majority of them opening onto the sea.
Building strategies	1. Buildings that are detached or semi-detached 2. Courtyards in the center 3. Inwardly orientated in part 4. High ceilings and windows 5. Large and open verandas 6. Roofs that are mostly flat 7. Buildings were elevated roughly one meter above the ground, with few exceptions lacking basements. 8. Inclusion of wind turbines in structures in various Persian Gulf coast cities and villages
Materials	1. Wood 2. Rubble 3. Coral stone 4. Brick 5. Adobe

5.1.3. THE MOUNTAINOUS AND HIGH PLATEAU REGION – COLD CLIMATE

Climate conditions	1. Extremely cold temperatures and wind chills throughout the winter months, particularly in the northwestern region. 2. A significant amount of snowfall, mostly in the northern and northwestern regions. 3. Conditions tend to be pleasant throughout the summer months. 4. Relative humidity tends to be low, particularly during the summer months. 5. Summers see very little precipitation. 6. There is a significant temperature range between day and night. 7. The valleys have high heat in the summer and moderate temperatures in the winter.
Urban and sub-urban fabric	1. Dense and compact urban layouts 2. Confined urban areas 3. City fabric orientation toward the southern winter sun 4. The significance of topography in the design of the urban fabric and its many components 5. In the foothill's communities, the major pathways ran along to contour lines, while the lesser ones ran perpendicular to them.
Building strategies	1. The buildings were connected 2. The buildings were inwardly orientated, with a central courtyard. 3. Low ceiling heights 4. Houses with flat roofs made of wood, mud, and straw. 5. With the exception of the south side, the apertures were quite small. 6. No or small verandas 7. Thick masonry walls
Materials	1. Rubble 2. Timber 3. Adobe 4. Straw

5.1.4. THE CENTRAL PLATEAU REGION – HOT AND DRY CLIMATE

Climate conditions	1. Summer is hot and dry; winter is freezing and dry. 2. Very little precipitation, especially in the summer 3. Low relative humidity, especially in the summer 4. There isn't much greenery. 5. Significant temperature differences between day and night Sandstorms in and around the world's two most populous deserts.
Urban and sub-urban fabric	1. Compactness 2. Urban enclosing 3. Narrow and erratic allies, sometimes housed in vaults or domes 4. Structures that are related 5. The prevailing winds and sunlight were the two primary concerns for the orientation and design of the urban fabric. 6. Qanats
GIS analysis	1. Seasonal rivers and lakes 2. Rich in resources 3. Bad basin situation 4. Low amount of rain 5. Almost flat land
Building strategies	1. Every building featured a central open space. 2. The structures were arranged facing inward. 3. Most of the buildings included basements, verandas, and wind catchers. 4. The ground floor levels of the houses and courtyards were lower than the entry and street levels. 5. The roofs of the buildings were covered with brick or adobe arches or domes. 6. The southern side of the courtyards had high ceilings. 7. The walls were made of sturdy masonry. 8. There were homes designed for use in all seasons.
Materials	1. Brick 2. Mud 3. Clay

5.2. SUSTAINABLE ARCHITECTURE STRATEGIES IN IRAN: ADAPTING TO DIVERSE CLIMATE ZONES

Iran, a country rich in history and culture, is known for its diverse landscape and varied climate zones, ranging from the northern coastal region to the mountainous and high plateau region. The country's architectural heritage reflects its diverse cultural influences, including Persian, Ottoman, and Islamic styles. In contemporary times, Iranian architecture has evolved to incorporate sustainability strategies that are specific to each of the country's four climate zones.

The northern coastal region of Iran has a temperate climate and is characterized by high precipitation levels and moderate temperatures. In this region, contemporary architecture strategies focus on the use of natural ventilation and shading to reduce energy consumption and improve indoor comfort. Architects use materials and techniques that are appropriate for the local climate, such as double-skinned facades, green roofs, and shading devices, to minimize the need for air conditioning.

The southern coastal region, which is hot and humid, requires different sustainability strategies. In this region, architects prioritize the use of natural ventilation and shading to reduce heat gains and improve indoor comfort. Passive cooling techniques, such as the courtyard and light wells, are also used to reduce the need for air conditioning. Building materials and techniques are selected based on their thermal performance, with a focus on using local, renewable, and low-impact materials.

In the mountainous and high plateau region, which has a cold climate, contemporary architecture strategies prioritize energy efficiency and comfort. Buildings in this region are designed to minimize heat losses and maximize natural light and ventilation. Energy-efficient materials, such as insulation and double-glazed windows, are used to reduce heating requirements. In addition, architects use traditional building techniques, such as roof insulation and the use of local materials, to create sustainable, low-impact structures.

Finally, in the central plateau region, which has a hot and dry climate, contemporary architecture strategies focus on reducing heat gains and minimizing the need for air conditioning. Architects in this region use shading devices, green roofs, and permeable paving to reduce the urban heat island effect and improve indoor comfort. Passive cooling techniques, such as cross-ventilation and evaporative cooling, are also used to reduce the need for air conditioning.

In conclusion, contemporary architecture strategies in Iran are tailored to the specific climate conditions of each region, with a focus on sustainable design that reduces energy consumption, improves indoor comfort, and preserves the country's rich architectural heritage.

5.2.1. CONTEMPORARY RECOMMENDATION FOR EACH CLIMATE

THE NORTHERN COASTAL REGION - TEMPERATE CLIMATE	1. Face the building towards the ocean breeze. 2. Limit the depth of the structure to a single room. 3. Construct the building on elevated pillars. 4. Ensure that the southern windows and ledges are unobstructed. 5. The building has balconies encircling it. 6. Implement a peaked roof design. 7. Incorporate a greenhouse into the peaked roof design.
THE SOUTHERN COASTRAL REGION - HOT AND HUMID CLIMATE	1. Position the building to take advantage of the sea breeze. 2. Keep the depth of the building limited to a single room. 3. Build the structure on elevated columns. 4. Incorporate large balconies, especially on the east-south and west sides. 5. Utilize the area above the stairs as a wind catcher.
THE MOUNTAINOUS AND HIGH PLATEAU REGION – COLD CLIMATE	1. Face the building in a southerly direction. 2. Build the structure at ground level, with a focus on the east, north, and west sides. 3. Design a basement with south-facing windows. 4. Ensure that the south windows and balustrades are transparent. 5. Utilize the area above the staircase as a greenhouse.
THE CENTRAL PLATEAU REGION – HOT AND DRY CLIMATE	1. Face the construction towards the south. 2. Construct the building at ground level, with an emphasis on the east, north, and west sides. 3. Have south-facing windows and railings that allow for transparency. 4. Incorporate a basement with windows oriented towards the south. 5. Include a sunken courtyard. 6. Transform the space above the staircase into both a greenhouse and wind catcher.

CHAPTER 6

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