

Function Analysis of Gowdal-Baghche (Sunken Garden), in Traditional-Vernacular Houses of Iran

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ABSTRACT

The study of architectural patterns in traditional-Vernacular houses of Iran indicates that main courtyard, *gowdal-baghche* (sunken garden), cellar and basement, *badgir* (wind-catcher), *eyvan*, etc. can be employed in order to conserve energy and reduce environmental pollution. One of the influential factors in the development of architecture in any region is the adjustment of buildings to its climate and environment. In the traditional architecture of Iran, sunken garden is considered to be a symbol of construction in accordance with the climatic features. Correspondingly, relying on the principles of sustainable architecture and utilization of natural energies, sunken gardens have been able to bring about climatic comfort for the residents. Aiming at the function analysis of sunken gardens, the present study examines their functional system and the construction method, and the construction materials employed, drawing on field study and analytical methods.

KEY WORDS: Vernacular architecture, *gowdal-baghche* (sunken garden), traditional houses, tropical and dry climate.

1- INTRODUCTION

The study of Iranian architectural typology indicates that buildings, either individual or in complexes, have been developed based on three spatial patterns: open, closed, and covered spaces. In historical houses, the courtyard and sunken garden, both as the main open space, represent symbiosis with nature. One of the best courtyards with climatic approach can be found in historical buildings of the desert and tropical regions of Iran. In these regions, the courtyard exhibits itself in the form of sunken garden with a surface adorned by trees, water, and soil. Here, sunken garden is developed as a small, appropriate climate to provide comfort.

In the past, architects employed efficient methods to create comfort in the cities and buildings. In the traditional architecture of Iran, architecture is so consistent with the environment that the best interior space comfort has been made possible without the use of energy-consuming appliances. This has been attained regarding the geographical location of the building through the making of the roofs, reducing the exterior surfaces of the building against direct sunlight, establishment of appropriate sunshades, wind-catchers, deep basements, central courtyards, shadow-casting walls, windows toward the sun, selecting the right construction material, etc.^[4]

The history of setting up the sunken garden in the hot and dry regions is so long that the studies conducted so far have not been able to shed light on it all. Talib writes in his book that the courtyards of sunken garden have been found in the ground from 3000 BCE. One of the best-known courtyards is in the village of Matmata in southern Tunisia. Regarding the examples provided by Talib, one can understand that these cases belong to the distant past and any doubt about their antiquity is erased^[19].

2- MATERIALS AND METHODS

The aforementioned research method is analytic-descriptive in terms of objective, application and process. Data collection is based on field work, documentary, and library research. Applying the above mentioned methods, this paper tries to study the functioning of sunken garden in the vernacular-traditional houses of Iran and the effects of sunken gardens on bioclimatic comfort of the residents and also on the sustainability of the environment.

3- Sunken garden

Sunken gardens were built in the heart of the main courtyards and stood one level lower, inside the ground. Examples of such spaces can be found in tropical and dry climates of Iran, in cities like Kashan, Nain, and Yazd. In addition to providing the necessary soil for the mudbricks used in construction of the building, a sunken garden made the water of *qanat* accessible. Porticoes and sometimes some rooms in the form of semi-

open spaces were often built on the sides of the courtyard where growing pomegranate, pistachio, and fig trees were also common. These courtyards, regarding their rather small size and low level and the fact that they employ the moisture and chill from the ground, beside the moisture of the plants and chill from water, are in fact created a much more climatic space. The houses in the desert were built on lower levels from the ground so that the building be heat- and sound- proof, more resistant against earthquake, and the availability of qanat water be easier ^[16]. In some instances the sunken garden encompassed parts of the surface of the main courtyard and therefore the courtyard had two levels ^[18].



Figure 1&2. Different views of a house in dry and tropical region which has been built in the form of sunken garden

Source: The present authors

Other than supplying water from the underground currents, sunken gardens provide cool and pleasant sites for the scorching summer of those regions. These spaces are fine shelters for the sunstruck people since sometimes there is significant difference in temperature between the sunken garden and the courtyard ^[17]. After developing the pond, garden and the sunken garden, moisture increases in the living space of the building and this is one of the best types of courtyards with a climatic life approach in the deserts of Iran ^[8]. The depth and low of courtyards in these houses does not inhibit the sun to shine on the lowest points of the house; this in turn contributes to the regulation of the weather in lower sections of the houses ^[11].

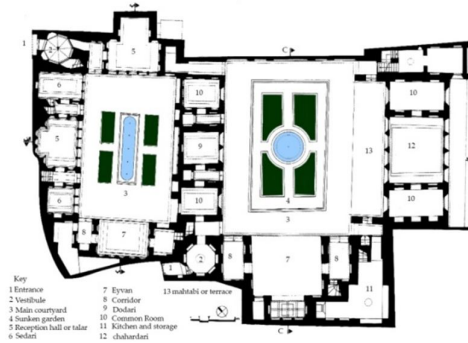


Figure 3. Ground floor plan and list of spaces in a house of the dry and tropical region which have been built in the form of sunken garden

Source: Redrawn by the authors

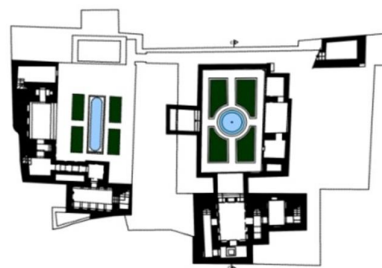


Figure4: Basement floor or cellar plan

Source: Redrawn by the authors

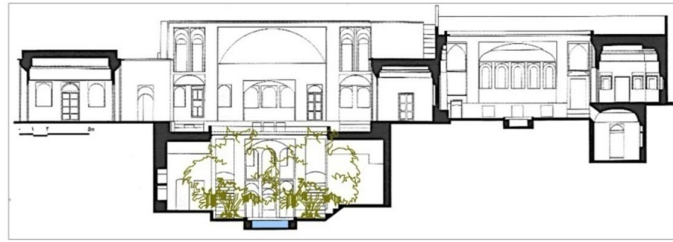


Figure5: Section C-C
Source: Redrawn by the authors

4- Functional system in sunken gardens

Lumps of soil act as a major obstacle to the high temperatures of tropical climates. Two meters below the level ground, soil temperature is pleasant while open air is sometimes below zero and sometimes scorching. However, a house located two meters below the level ground is much cooler in the summer and warmer in the winter than those on the ground are. In the summer, soil is cool enough to act as a heat absorbent during the hot days^[13].

Similarly, employing the stable temperature of the ground, these houses can reduce the fluctuation of temperature inside them^[19]. Temperature fluctuation in houses which are built as a form of sunken garden inside the ground is significantly lower than in their counterparts on the level ground. These houses also have clear advantages regarding thermal comfort and economy of the energy^[5]. Not only are these houses beneficial in terms of comfort, but they are also economical in terms of using the construction materials and their durability^[3].

In sunken gardens the surface of the ground acts as a thick insulator against heat which does not allow the transfer of heat into the ground^[11]. The presence of sunken garden also leads to proper utilization of air circulation so that artificial cooling equipments are no longer necessary and energy consumption be reduced^[14].

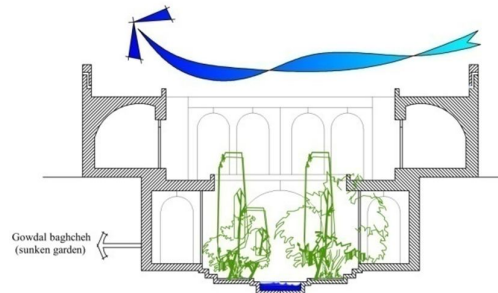


Figure 6. Inaccessibility of the interior space by extremely strong winds of desert
Source: The present authors

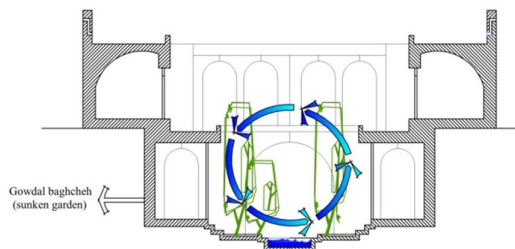


Figure 7. proper air circulation in the heart of residential area
Source: The present authors

5- Method of the construction of sunken garden

Construction of sunken gardens consists of the following three stages (Figure 8):

- 1) Excavating the ground in order to use the soil,
- 2) Building the supporting piers which act as underpinning,
- 3) Constructing the building in the basement and setting up the sunken garden,
- 4) Constructing the main building of entrance spaces above the ground.

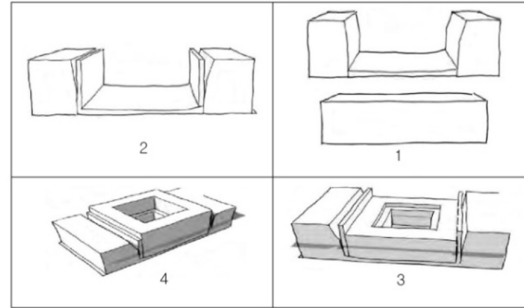


Figure 8. The stages of constructing sunken garden^[11]

6- Materials used in construction of sunken gardens

In the dry and tropical regions of Iran, the type of materials used in the building can have a significant effect in the comfort of the residents. In these climates chosen materials must be highly resistant against heat and have a high thermal capacity. Among the materials used are mud and its derivatives. It is important to say that the mud is made out of the soil from the same place after the excavation; this saves energy, time, and cost. Another point in construction of the building is the thickness of the materials. Thickness of the walls must make them resistant enough against the long exposure to strong sunlight. The color on the surface of materials used in the building must be light so that it can reflect much of the sunlight. The light color of the soil is the best color which can be used for the chosen materials in tropical regions^[11]. In other words, all materials are supplied from the local resources. In provision of the materials, not only is no damage done to the natural environment, but the natural essence is also enhanced^[9].

The space surrounding the sunken garden is the same space of the residential house. The bottom of the sunken garden is paved with bricks^[15].

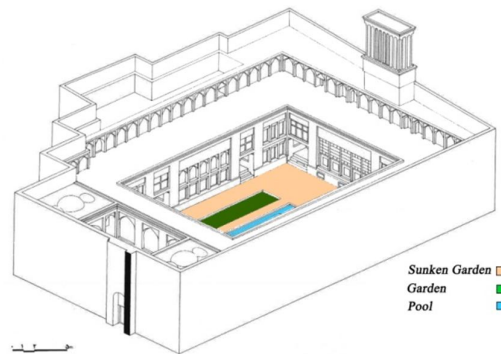


Figure 9: Shafipour's House in the city of Yazd, built in the form of a sunken garden
Source: Redrawn by the authors

7- Sunken garden: saving cost and energy

Because of the absence of facilities and technology in the past, Iranian architects drew on the environment and its energies to remove climatic problems by the lowest cost possible. Iranian architects saved time and energy in sunken gardens through making vaporized moisture by the trees, cleaning the air, directing it into the rooms, and employing the local materials.

Table 1. Sunken garden and its economical effects

Economical characteristics of sunken gardens	
1	minimizing the need to fossil fuels and reducing energy consumption
2	utilizing non-fossil fuels, and renewable energies such as wind and solar energy
3	reducing the use of modern sources of materials
4	meeting the building needs with the lowest cost possible
5	simpler and more cost-effective use of underground water like qanat

8- Sunken garden and bioclimatic considerations

Local houses of the desert with their central open spaces act admirably in adjusting to the searing heat of the region. Climatic conditions are crucial in the development of sunken gardens, main courtyard and other parts of these houses^[1]. Ardalan and Bakhtyar, too, regard the configuration of space in traditional architecture of

Iran as the offspring of factors such as climate: “above all, it is the climatic conditions which make courtyard-centered houses in this region a must for healthy life” [2]. All the components of the house work together in these courtyards to bring about a small livable climate for the residents. The courtyard acts as a smart element against cold, heat, humidity and wind, and like a natural oasis, it brings light, water, wind and plants together to provide comfort for the residents in unpleasant circumstances.

Sunken gardens and wooded courtyards, with pond and planted surfaces which need a little water, are among the most effective factors creating moisture in the dry regions of the desert. The rooms which open toward the sunken garden are protected against the wind and sandstorm [10].

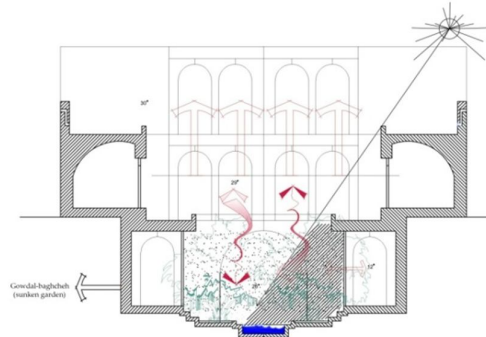


Figure 10. Function analysis of sunken garden in vernacular houses of Iran.
Source: The present authors

9- Flora in sunken garden

The flora of the region is used to keep out sand and dust. The presence of flora also leads to more moisture for the residential spaces.

Because In the dry and tropical climates of Iran, green space is considered crucial in microclimates around the building, owing to:

- Effective reducing of direct sunshine
- Throwing shadow over the roof, walls, windows, and the courtyard
- Reducing sand and dust around the courtyard
- Reducing the speed of unwanted winds around the building [6]
- Concentrating the wind current and increasing its speed in the desired direction
- Increasing humidity in dry climates
- Reducing temperature around the building [11]



Figure 11: an example of the flora used in a sunken garden [7]

10- Conclusion

Regarding what has been discussed so far, architecture of sunken garden in the desert houses of Iran has developed to utilize renewable energies such as wind and sunlight properly; this leads to a reduction in fossil fuel consumption and, consequently, to a sustainable environment.

As to the studies about the dry and tropical climate of Iran and its traditional houses, the most significant functions of sunken garden and its influences on the bioclimatic comfort of its residents and on the sustainability of the environment are as follows:

- Using local construction materials which results in sustainability and saving energy (construction is carried on by using the soil produced after excavation)

- Using climatic strategies to cooperate appropriately with the environment and to increase the bioclimatic comfort
- Increasing the bearing capacity by excavating the courtyard and reaching compact earth
- Contributing to the structural strength of the building against lateral forces such as wind, earthquake, etc.
- Providing a pleasant and cool space in a dry and tropical climate through circulating and conditioning the air in the sunken garden environment
- Reducing the absorption of heat through proper overshadowing and planting trees in the sunken garden
- Appropriate utilizing of resources and energies
- Integrating residential environments within nature which results in cooperation and variation in living environments
- Creating harmony between the climatic comfort and culture, tradition, and beliefs
- Easy and inexpensive access to the underground water and qanat

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