Sustainable Features of Vernacular Houses in Hawraman

[1]Ahmed Q Ahmed

1PhD Student at Architecture Department – University of Sulaimani

Abstract

The awareness of sustainable building's potential to reduce the negative environmental impacts has been grown during the last decades. This pushed the vernacular architecture to the sustainable discourse in order to understand how to apply local sustainable considerations to buildings in a particular location. Vernacular architecture gives simple and basic solutions for the environmental issues since it has important environmentally features that respond to sustainability. In this regard, the purpose of this study is to examine vernacular houses in Tawela, where is located in Iraqi Hawraman, so as to explore the local inherited experiences dealing with the environmental issues. In the study, an example is used with reference to literature to analyse settlement pattern, building form and orientation, construction materials and techniques, openings and shading as well as energy efficiency in vernacular settlement of Tawela. This will provide significant climatic design strategies and building construction techniques for designers who are involved in sustainable development of built environment. The results show special architectural solutions for environmental issues in particular mountainous area. These solutions have been the sustainable features of architecture in this area.

Keywords: Sustainability, Sustainable feature, Vernacular Architecture, Tawela, Hawraman, Vernacular House

1. Introduction

1.1. Environmental Sustainability:

In the 42nd General Assembly of United Nations in 1987, the term 'sustainability' is defined as 'meeting the needs of today without sacrificing the ability of future generations to meet their own needs'. It has three main pillars: economic, environmental, and social (Karakul, 2016). This research focuses on environmental stationarity, which is "the quality of causing little or no damage to the environment and therefore able to continue for a long time" (Cambridge Dictionary, n.d.). In other words, the environmental sustainability in architecture refers to reducing and eliminating the negative building impacts on the environment from the production of building materials and construction of the building to the building operating and finally demolition of the building at the end of the useful life (Piquer, 2003).

In the last two decades, a significant shift to the new design strategies has been observed in which sustainable building features are significantly considered. Professionals in both design

and construction disciplines continually seek for best solutions in practices in order to understand of how to apply sustainable considerations to buildings (Halıcıoğlu, 2012). This is to respond to the recent environmental crises such as climate change and global warming due to the ecological footprint and pollutions as well as excessive fossil fuel energy consumption.

Sustainability in architecture requires environmentally friendly approaches in which certain significant issues should be considered including: Energy consumption, energy efficiency, the use of renewable energy; the use of local materials; indoor environmental quality and thermal comfort; fresh water consumption and water efficiency; waste management and recycling; access to public transport, cycling facilities and walkability; Greenhouse gas emissions, land use, local ecology, contextual fit and social relations. (Halıcıoğlu, 2012).

1.2. Vernacular Architecture:

According to the Word Sense Dictionary, the origin of "vernacular" is from the Latin word vernaculus which means "domestic, native or indigenous" (WordSense.eu Dictionary, n.d.). In Definitions.net Dictionary "Vernacular architecture" is defined as "a category of architecture based on local needs and construction materials, and reflecting local traditions. It tends to evolve over time to reflect the environmental, cultural, technological, and historical context in which it exists". It also stated that this kind of architecture is not academically planned (Definitions, n.d.); and is known by architecture without architects (Sari, Izziah, Irwansyah, & Meutia, 2017).

In vernacular architecture, certain design techniques and particular building forms are used which are time-generated solutions for the related climatic conditions. These traditional and vernacular solutions have been developed during centuries by indigenous residents. They were aware of the beneficial methods from certain climatic characteristics and controlling unfavorable ways through choosing appropriate solutions by formulating design rules for site selection, settling arrangements, energy efficiency, building form and orientation as well as material and construction methods of the buildings (Ahmed, 2013) and (Hosseini & Shangapour, 2010). Vernacular architecture, which has developed by trial-and-error methods, disclose the integration of local climate conditions, local available materials, basic construction techniques, life style, culture and socioeconomic conditions in a particular area (Halıcıoğlu, 2012). Recently, most of the designers adapt vernacular design techniques and building forms as main strategies and concepts in their climatic responsive designs due to the increasing challenges about providing sustainability in the built environments (Ahmed, 2013).

Vernacular architecture in Kurdistan has been rarely studied so far. Due to the rapid development in the Iraqi Kurdistan region and the lack of a clear knowledge of vernacular architecture, there is a lack of locality and sustainable adaptation in newly developed architecture. The local architecture strategies and techniques, which can be found from vernacular architecture, should be considered in recent developments. Exploring and examining rural settlements in mountainous areas in Kurdistan will provide valuable knowledge about sustainable building practices. Consequently, it will be useful in finding more adaptable climatic solutions and identifying the sustainable features of these indigenous settlements in order to be used in contemporary designs (Rostam D. , 2017).

1.3. Research question

Hence, this investigation seeks to answer the question; to what extent the features of vernacular houses in Tawela village in Hawraman area are environmentally sustainable? Is there a potential in these features for using as climatic responsive design strategies in contemporary buildings?

1.4. Research objectives

Vernacular architecture can be considered as inherited unwritten information and practical experience related to sustainable architecture. Therefore, it is accepted as a basic knowledge source for sustainable building design concepts. In addition, environmental sustainability, as one of the aspects of sustainability, can be learned from vernacular architecture in a particular region in order to be implemented in architecture in that region. The main objective of this study is to explore and analyse environmentally-responsive features of vernacular architecture in sustainability context of Hawraman Architecture. This will provide significant insights and lessons as strategies and techniques for designers and researchers who are involved in the development of future sustainable built environments especially in continental mountainous areas.

In addition, Tawela village and its vernacular settlement almost was destroyed during the Iraq-Iran war in the 1980s; and the area was evacuated for about 11 years. Then, it was almost rebuilt in the 1990s with different vernacular and modern materials and techniques. The number of building houses in vernacular approaches is declining and existing remaining vernacular houses are facing damage without maintaining. Consequently, the damaged houses will be replaced by modern structures, which are easier and cheaper to build. This research brings focus on vernacular architecture in this area and can be considered as a documentation for later use.

2. Literature review and research gap

Studying and examining traditional and vernacular architecture had started in the 18th century. Different features were considered in the researches at that time. Some of them had introduced the traditional architecture as national architecture. In the 20th century, traditional and vernacular architecture came to the theory of architecture (Morad & Ismail, 2017). There are many recent studies examining vernacular architecture in different perspectives.

Certain recent studies focus on environmental characteristics of vernacular architecture in different regions. Halıcıoğlu in her research analyses the vernacular architecutre of Şirince village, in western Turkey, in terms of sustainable considerations (Halıcıoğlu, 2012). A study titled (*An Environmental Assessment of Vernacular Housing in Banda Aceh, Indonesia*) assess the environmental quality of the traditional, transitional and modern houses in term of local wisdom, embodied energy and thermal comfort. The authors state that "local wisdom is a sustainable characteristic that talks about adaptive integration with culture and local climate" (Sari, Izziah, Irwansyah, & Meutia, 2017). In addition, according to (Al Tawayha, Braganca, & Mateus, 2019), residential buildings in the new Mediterranean cities are far away from the sustainability principles; whereas, the old cities are close to it. It also suggests guidelines categories manual for designers. Furthermore, (Karakul, 2016) Discovers the ecological principles of traditional architecture in Cappadocia Region for creating more liveable and sustainable environments. Moreover, Bougiatioti, Papagiannakis and Oikonomou identify the environmental features in the design of the vernacular settlement of Psarades in northwest of Greece.

There are two different studies by Morad and Ismail; and Abbas and Khaznadar examining vernacular architecture in Erbil city. The first study explores main climate response strategies to achieve thermal comfort for future houses (Morad & Ismail, 2017). The second study, which

is about renovation of vernacular buildings, concluded that the reusing vernacular buildings requires a balance between the new function and conservation. In addition, in a research titled (*Sustainable Construction in Kurdish Vernacular Architecture*), the author outlines the characteristics of Kurdish vernacular architecture in Erbil city and the villages in mountainous areas; and then analyses them in terms of sustainability (Khoshnaw, 2019).

There are certain recent researches on vernacular architecture in Hawraman. A study conducted by Hamejani, Bayzidi and Sahabi in 2018, on meaning in architecture, discovers and formulates the meanings of vernacular architecture in Hawraman-Takht (Hamejani, Bayzidi, & Sahabi, 2018). Furthermore, Hosseini and Shangapour investigated Hawraman's villages from the climatic conditions, social context and vernacular economy perspectives to find out sustainable approaches to design of a residential complex in a tourist village in a mountainous area (Hosseini & Shangapour, 2010). Amini and Noori in their research reveale that Hawraman architecture was formed in the light of its culture and in harmony with nature (Amini & Noori, 2019). Furthermore, a study recognises the identity of vernacular architecture in Hawraman as Islamic and Iranian identity and looks for its symbols (Molanaei & Soleimani, 2017). Moreover, Rostam examines characteristics of evolved sustainable building engineering in vernacular architecture of Kurdistan (Rostam D. , 2017).

There have been mentioned certain studies focusing on vernacular architecture in different regions about different aspects. Some of them examines sustainable features of the vernacular architecture in different cities and areas of Kurdistan; and only a few papers discuss sustainable features of vernacular architecture in Hawraman. There is a lack of studies investigating aforementioned topic in Tawela village, where a unique architecture with specific environmental solutions exists and the number of studies about it is limited.

3. Research Focus and limitations

This research intends to examine vernacular houses in the Tawela village which is located in Iraqi Hawraman area. Hawraman is a wide mountainous area with certain villages which is divided to two parts in Iraq and Iran. Its settlements and special architecture have a significant role in defining architectural and urban values in Kurdistan. Selecting this area, Tawela village in particular, for doing a case study refers that this area is geographically and ecologically distinct from other areas of Kurdistan. Its mountainous and harsh climatic conditions have affected livelihood, lifestyle and architecture. Understanding these characteristics, features and their effects on the architecture of the area is valuable in architectural field (Hamejani, Bayzidi, & Sahabi, 2018). In addition, vernacular houses have different characteristics and features. In this research, only the environmentally sustainable features will be investigated in terms of settlement pattern, building form and orientation, construction materials and techniques, openings and shading as well as energy efficiency.

4. Research method

In this qualitative research, explorative method was used to examine and explore sustainable features in an existing vernacular rural area based on literatures and example. Using example, which is a village, gives chance to new investigations and provides detailed examinations and also a rich exploration. So, settlements and certain vernacular houses in Tawela village in

Hawraman area were selected as case studies. Most of the houses in Tawela are vernacular and still are in a reasonable condition.

Precisely, this research was carried out to find out the existing sustainable considerations and strategies such as compatibility with climatic conditions and topography, building configurations, used materials and construction techniques and also passive air conditioning solutions in the vernacular buildings in continental climatic conditions of the region. For that reason, vernacular settlement in Tawela were analysed in terms of settlement pattern, shape and type of the buildings and their orientation, construction materials and techniques, design and proportion of openings and their shading as well as passive solar heating and natural ventilation and cooling in relation to environmental sustainability. In addition, examining the case studies were supported by certain related literatures, photos and drawings. Finally, results and findings were discussed in terms of environmentally sustainable considerations.

5. Tawela village as an example

5.1. Climate of Hawraman:

According to the Köppen Climate Classification, the climate of Hawraman area, Tawela in particular, is continental climate with warm dry summer and cold wet winter (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006). This climate is characterized by large seasonal temperature differences, with warm to hot summers and cold (sometimes severely cold) winters. The average precipitation for Hawraman is approximately 440 millimetres per year. However, most of that falls during November through May. The rainfall is rarely seen during the summer months. In terms of the air temperature, there is large seasonal temperature differences for the year in Hawraman. The warmest month, on average, is July with an average temperature of 25°C and the coolest month on average is January, with an average temperature of -2.6°C (Figure 1) (weatherbase, n.d.).

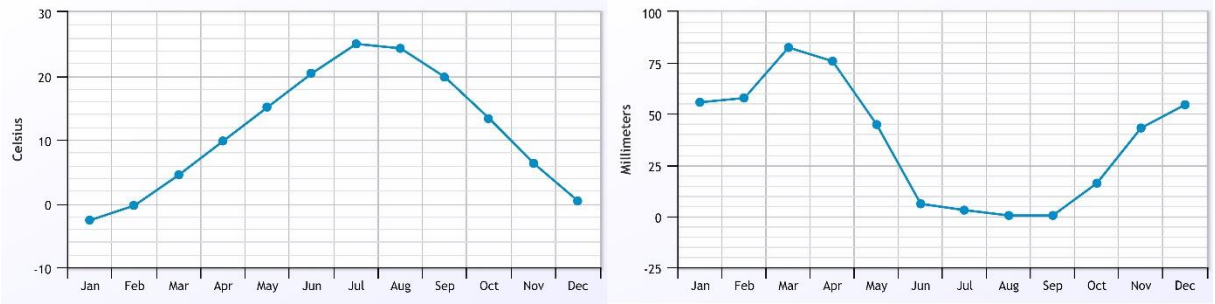

Figure 1: left: annual average temperature; right: annual aerage percipitation in Tawela; source: (weatherbase, n.d.)

5.2. Settlement Pattern:

There are two rivers which flow from east and northwest and meet at the centre of Tawela; then, the new river flows toward the south. These divide the settlement into three neighbourhoods and give a Y-shape to the settlement. Agricultural fields such as fruit gardens and vineyards are mostly located outside the settlement along the riverbeds and on the mountains respectively. Tawela village was conveniently located on sloping terrains with a terraced pattern. There is only a road to access to the village, which is the main vehicular axis. This road is divided to two parts at the centre of the village and goes along the riverbeds. The rest axes are pedestrian

alleys which are mostly stepped, narrow and irregular paths because of the topography. The topography is consisted of steep slopes which influences the location of the houses and the form of the streets in the village. The houses are located on the three sides of the Y-shape settlement.

Most of the houses are located on the south-facing hillside to receive the maximum amount of sunlight. This is an adaptive strategy which is used in cold mountainous climates. The rest of the houses are located on the east-facing and west-facing hillsides. This is due to the lack of space in the preferable hillside to build new houses. Most of the houses are double-story standing against the mountain slopes. Khoshnaw in his research stated that "Houses in the mountainous areas are arranged in specific terraces to ensure the interdependency of each household on the other. Also, their structure is in the form of a stairway to overcome the contour layout problems. It is an easily available material and offers a protective environment for the inhabitants since the region is prone to strong winds, rain and heavy snow" (Khoshnaw, 2019). Housing in all cases is based on topography and natural terrain as well as local available resources, which are mainly stone, wood and soil. Therefore, the urban structure is well integrated with the nature. In this type of settlement, human interaction with nature reaches its maximum (Figure 2).

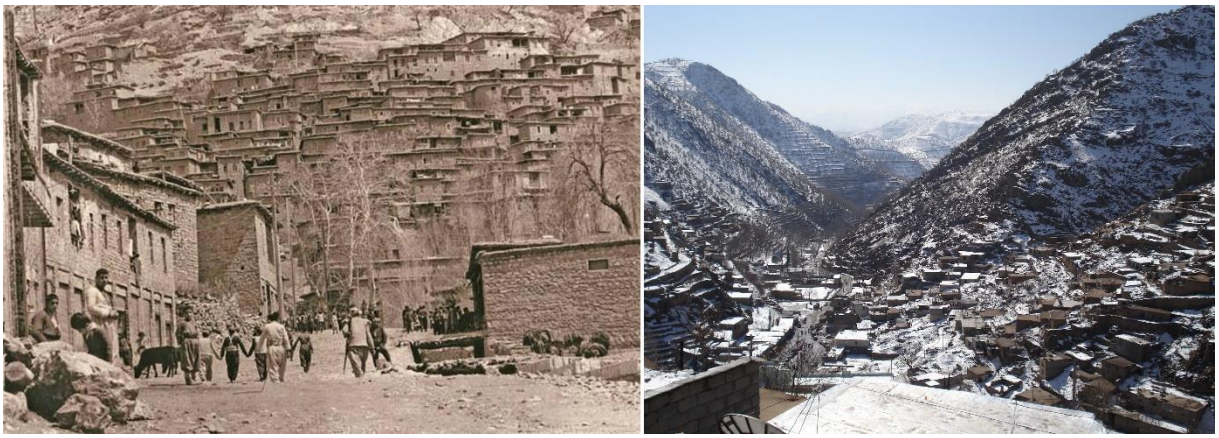

Figure 2:Tawela village, left: (William Carter, 1965), right: (Author, 2007)

5.3. Building Form and Orientation:

Configuration of houses is mainly affected by topography and the houses are placed parallel to topography. The houses are built as a detached or attached houses with respect to each other and without blocking view, solar radiation and wind of each other. The form of the houses is mostly rectangular and compacted. The two-story houses are usual; whereas, one-story and three-story houses are quite few. Introverted features are used in the ground floor while extroverted features are used in upper floors. Ground floors are mostly used for services, storage and livestock. The living areas such as living room, kitchen and bedrooms are located in upper floors. Front yard and entrance space is not usual and most of the houses entered directly from the alley.

Compactness of the form is the first measure to reduce the harsh effects of wind and weather and heat loss as well. Relative size and opening ratio of each façade plays a major role in the energy efficiency of houses in Hawraman. So as to reducing thermal conduction, buildings tend to be very compact for minimising the surface (area-to-volume ratio) and share walls for reducing exposed surface area. The openings in south direction are larger to gain maximum solar energy. While, the windows in other direction are smaller especially in north and west directions. A part of the buildings' form is hidden because of locating in the heart of the rocky

mountain and merging with the terrain. In addition, the rocks like barriers protect the buildings form penetrating cold winds and create calm and supported area. Ceilings are very low in order to decrease the interior volume rather than exterior surface. This causes decreasing the heat loss and as well as the inner spaces are heated more rapidly (Figure 3).

Houses in Tawela have been built for the entire year. Rostam pointed out that "there is also a seasonal pattern to the occupation of space by which people sleep on the front veranda or on the flat roof during summertime. Often an open veranda (eywan) is created in front of the house" (Rostam D. , 2017). In Hawraman, the semi-open spaces and open spaces are called "heywan" and "barheywan) respectively.

Figure 3: Typical vernacular house in Tawela (Photos: Author, 2007)

5.4. Construction Materials and Techniques:

It is observed that stone, wood and soil are used as main construction materials which are available locally in this area. Stone is mostly used in foundation and walls and even is used in the roof layers. Wood is used for certain purposes such as column, beam, dimak[1] and mrola[2] as well as windows and doors. Soil is used as mortar, plaster and roof damp proofing course. In addition, construction technique of Tawela houses is load bearing masonry wall.

5.4.1. Walls:

The walls, which are very thick, are constructed by stone. The external walls have two layers (internal and external stone walls) and the gap between the layers is filled by clay mortar and crushed stone. Such walls reduce the heat transfer through the wall and help to moderate the indoor environment. However, these thick walls also carry the load of the roof. The used stones are solid, heavy and moisture resistant, in the form of block or slates. The stones in construction of these walls are of great size and variety in terms of component selection, shape optimization, fitting and layout. Amini and Noori found out that "the stones in the area are cut and used in

[1] Dimak (دیمەک) is a large, rectangular cubic blocks of timber used in rows of the rocky walls of buildings. Due to their high resistance to corrosion by water, these timbers are mostly made of mulberry trees and are used intermittently in the walls of the building and are repeated in every four courses up to eight courses of the wall (Amini & Noori, 2019).

[2] Mrola (مرولە) is a short block of wood from mulberry trees and is used across the masonry walls especially in foundation (Rostam A. , 2011).

the shape of cubes or rectangular cubes after excavation. Although the shapes of the stones used in these indigenous structures follow the same purpose, which is the combination of strength and beauty, they are still highly varied in different ways of arranging or merging. On the exterior of the building, most of the rocks are cut into regular geometrical volumes (cognitive aesthetics), and in other cases, the more natural rocks (Stability and strength) are used. However, the shape of the stone partly determines their arrangement for solidification" (Amini & Noori, 2019). In addition, the indoor surfaces of the walls are covered with a white soil, which is obtained from a special place in the village called glejana, with certain actions of smoothing and polishing.

The arrangement and type of used materials have their own function. For example, dimak, which is used in the walls, is made of the old mulberry tree in the area and has the highest amount of pressure tolerance, dehumidification and resistance against decay. It is important to prevent the wall from cracking. Normally, if the cracks are caused by lateral forces or local seating on the wall body, this crack will not be complete and will stop at the location of dimak. Whereas, mrola is a shorter wooden block which is put in a stone course across the wall of the building. It also is used to connect the inner and outer courses of the wall and sometimes to connect the wall and foundation to the mountain. This prevents the building from being rolled over and being damaged during the earthquake (Figure 4) (Amini & Noori, 2019).

Figure 4: building construction components and materials in Tawela vernacular house, (photos: Author, 2007)

5.4.2. Roof and Ceiling:

Roofs in Hawraman houses are flat. The roofs are made of timber frameworks which are covered with layers of stone, mud and straw. Firstly, a thin layer of hand-sized thin stones called dela[3], that is often the result of cutting stone walls, covers the timber framework. Then, dela is covered with mud balls and compacted regularly. Later, the surface is fastened by straw and small aggregate called rzhak. A roller, which is made of stone and called bantlin, is used for compacting the roof when is required especially after raining and snowing. This prevents the roof from water penetration. In summertime, glejana is used for smoothing and polishing the roof to be used as sitting and gathering area especially in evening (Rostam A. , 2011). There is

[3] Dela (دێڵە) is a thin and palm-sized stones which are used to cover the timber framework of roof. (Rostam A. , 2011)

a gutter, which is called pasar, around the roof to prevent the walls from being wet in the rain and snow (Figure 4).

5.5. Openings and Shading:

The old windows and doors are completely wooden structures but some of the new windows made of steel. The division of windows is modular and their proportion is about 1/2. Thin pieces of wood-lath are nailed on window jamb and the glass is placed in between. The windows are often very small in order to reduce the heat loss. While, they are larger in south-facing facades to maximise the solar heat gain in cold seasons. In addition, usually a large glazed window, which is called jamkhana, covers the open side of the haywan (Iwan) especially where the heywan is facing the south. This is to maximise the view and solar heat gain. In terms of the doors in Tawela houses, entrance doors are often made of two equal slots. They were somewhat large and of sufficient thickness and strength. The large doors of the building or the main entrances are called gates. Furthermore, balconies and pasar (gutter) are also used as shading elements for windows and doors. Moreover, different types of deciduous plants such as trees and vines are used for shading purposes during summer seasons (Figure 5).

Figure 5: openings and multiple shading elements in vernacular house in Tawela (photo: Author 2018)

5.6. Energy efficiency:

One of the significant characteristics of houses in Tawela is their energy efficiency the minimum energy is used for air conditioning and lighting. Consequently, the green gas emissions, energy consumption and costs on the household reduces.

Hawraman's houses have been built for the entire year. In their interior design both ventilation in summer and passive heating measures in winter have been considered. In their functional layout the most used spaces are on the side of the house oriented towards the south sunshine while the least used spaces and barns have been situated on the back which can also act as additional thermal mass. (Hosseini & Shangapour, 2010)

In Hawraman solar gain has been achieved easily by careful selection of materials, windows placement, special arrangement depending on its activities and proper terrain. Due to the cold climate, the southern slopes are preferable to settle. The orientation of the buildings facing south is to maximise the passive solar heat gain. Since in the winter sunlight shines on the earth at

about 30 degrees angle, solar radiation is spread over a larger area, thus locating on slopes leads the sunlight to concentrate on a smaller area with a range of 60-80 degrees angle of shining dependent on the slope's angle of the hillside. This kind of arrangement in the slope causes buildings to expose in minimum shading retaining heat is the first step in conserving energy during the winter months. In addition, reducing surface exposure reduces heat loss through convection. Heat gets out mostly through openings such as windows where heat resistance is low, therefore openings are only placed where required either for lighting or ventilation aims. Thermal mass flooring materials has been used for absorbing heat during the day and released at night (Hosseini & Shangapour, 2010).

Since in Hawraman the wind and the accompanying cooling are the main issue, the density and arrangement of buildings are significant in decreasing the effects of the most annoying weather conditions. In the predominantly cold climate of Hawraman the priority is to protect against prevailing winds in cold seasons. Furthermore, trees and landforms are also used to protect against the cold winter winds (Hosseini & Shangapour, 2010).

6. Conclusion

In this study vernacular architecture was examined as a knowledge source for sustainable building solutions. The key features concerning sustainability in vernacular architecture were identified by analysing Tawela vernacular settlement and correspondingly houses in Hawraman. The most important goals of sustainable building projects are adaptation to flexible and changing environmental conditions, long life, energy conservation, low cost of maintenance, and providing humans with the best indoor air quality. In this respect, the result of this examination indicates that Hawraman vernacular architecture have significant sustainable features due to the fact that it incorporates the use of local materials and indigenous building sources, incentive to promote the continuation of low-tech and environmentally friendly solutions, and energy-efficient design principles. For example, most of the houses have some solar passive features such as direct solar heat gain through south facing windows, enhanced air circulation, promoting natural ventilation, reducing heat loss and effective shading solutions. In addition, Hawraman vernacular houses were built with the use of locally available limited resources to adapt themselves with the geo-climatic conditions of the terrain. Using locally available materials for construction of these houses decreases the building material processing and transportation costs. These houses have also provided energy efficiency and thermal comfort to the occupants of the settlement for most part of the year without using any artificial costly source of energy by using materials with less embodied and operational energy. Hence, Hawraman houses are not only vernacular but also reflect the sustainable features of a built environment. As a conclusion, the study demonstrates that vernacular settlements present a significant opportunity in order to discover experiences related to sustainability. Vernacular architecture has inherent benefits with its environmentally friendly approaches. Hence, vernacular architecture must be seen as a knowledge source that could inspire the designers and professionals interested in sustainability.

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