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VERNACULAR ARCHITECTURE FOR SUSTAINABLE RURAL DEVELOPMENT: A CASE STUDY OF KALEYBAR DISTRICT IN IRAN[1]

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Abstract

Located within Arasbaran Protected Zone, Kaleybar is an attractive rural tourism area of noticeable potential yet suffering from limited infrastructures. Vernacular architecture represents one of the major factors contributing into sustainable development of rural tourism.

The aim of this study is to evaluate the vernacular architecture of the region, in term of building typology and building physics. In order to evaluate vernacular architecture of Kaleybar area using the method of (Anna Maria 2009), six houses of five determined villages within the research area were selected. The plan and section of the houses were prepared through personal fieldwork, the author's measurements, sketches, observation and local people's interviews. Including layout (orientation in relation to the sun and wind, aspect ratio), spacing (open space), opening (size-position, semi-open spaces), building envelope (walls, roofs). These design principles of dwellings bases on a thoughtful approach to environment and climate.

These passive design principles of vernacular architecture can be utilized as ecological pattern in architectural practice within the region in relation to sustainable rural development.

Keywords

Vernacular Architecture

Sustainable Rural Development

Rural Buildings

Rural Tourism Arasbaran

SÜRDÜRÜLEBİLİR KIRSAL KALKINMA İÇİN YÖRESEL MİMARİ: KELEYBER BÖLGESİ (İRAN) ÖRNEĞİ

Özet

Arasbaran Koruma Bölgesi içinde yer alan Kaleybar vadisi, kısıtlı altyapısı ve göze çarpan potansiyelleri ile dikkat çekici bir kırsal turizm alanına sahiptir. Yöresel mimari, kırsal turizmin sürdürülebilir kalkınmasına katkıda bulunan en önemli faktörlerden birini temsil etmektedir.

Bu araştırmanın amacı, bölgenin tipik mimarisini bina tipolojisi ve bina fiziği açısından değerlendirmektedir. Kaleybar bölgesinin yöresel mimarisini değerlendirebilmek için (Anna Maria 2009) yönteminden yararlanarak; araştırma alanı içinde belirlenen beş köyden altı ev seçilmiştir. Evlerin plan ve kesitleri yazarın kişisel alan çalışmaları, ölçüleri, eskizleri, gözlem ve yerel halkın görüşmeleri ile hazırlanımştır. Değerlendirmeler yerleşim düzenini (güneş ve rüzgâra göre yönlendirme, en boy oranı), aralığı (açık alan), açıklığı (boyut-konum, yarı açık alanlar), bina örtüsünü (duvarlar, çatılar) içermektedir.

Araştırmadan elde edilen sonuçlara göre bölgenin yöresel mimari tasarım ilkeleri, tamamen çevre ve iklime düşünceli bir yaklaşıma dayanmaktadır. Yerel mimarinin pasif tasarım ilkelerin kullanılması, bölgedeki sürdürülebilir kırsal kalkınma ile ilgili mimari uygulamalarda önerilmektedir.

Anahtar Kelimeler

Yöresel Mimari

Sürdürülebilir Kırsal Kalkınma

Kırsal Binalar

Kırsal Turizm

Arasbaran

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1. INTRODUCTION

Arasbaran Protected Zone is a world-registered biosphere reserve with rich natural resources on which conservation limited studied have been performed. The area is located in northwestern Iran where pilot projects for sustainable development of rural tourism have been started. This industry can play a major role in preserving the nature resources. Rural tourism has experienced a great deal of growth over the past 20 years (Ferrari and Vargas-Vargas 2010; Tremblay 2006; Leco and Campón 2012). It further contributes to economic growth of the region (Danaci and Eser; Saarinen and Monkgogi, 2014; Koster, 2007). Sustainable rural tourism can be achieved through responding economical, cultural, and legal demands raised by society. Furthermore, tourists' expectations should be addressed in such a way that no harm is imposed to unity, cultural identity, environmental health, and economical balance of the destination (Turnock, 2002; Antic et al. 2017). The prominent feature of rural truism is sustainability of environment. It is essential to know that this industry will be attractive and innovative once its sustainability is maintained architectural and cultural heritages of past civilizations are preserved (Akgün et al., 2015; Sbarcea and Tudor 2016; Durak et al., 2011; Tunkçu et al., 2015; Garcia and Juan 2014). This paper demonstrates how an integrated approach can be successful in achieving sustainable development of rural tourism. This study explains the principles underlying vernacular architecture of Kaleybar area and suggests certain lessons to contemporary designs in rural tourism industry. These are environmentally sustainable and socially fulfilling. Vernacular architecture serves as a major factor in sustainable development of rural tourism where it can be used as a valuable ecological infrastructure, which is highly demanded. Vernacular architecture or architecture of common people is defined as buildings built by local people rather than professionals with the entire set of their priorities and interests; therefore, these show how various people's concerns have influenced design decisions (Miraftab, 1999; Ghaffarian Hoseini and Nur Dalilah, 2012). The preoccupation with the relationship between site and structure and responding to the environmental requirements including climate, topographic conditions, local materials and social lifestyle have been the main factors forming the vernacular architecture (Engin et el. 2007; Philokprou et el. 2017; Misra, 2016; Lawrence, 1983; Maudlin, 2010). Being based on traditions and cultures, vernacular architecture has been accessed through a long trial-and-error process undertaken by local people who well know their neighborhood. This knowledge has a particular ecological value (Anna-Maria, 2009; Esin and Yuksek, 2010; Zhai and Jonathan, 2010). The aim of this study is to evaluate the vernacular architecture of the region, in term of building typology and building physics. These design principles of dwellings bases on a thoughtful approach to environment and climate. These passive design principles serve as a tool for implementing sustainable development of rural tourism.

2. MATERIAL

2.1. Location of the study area

The study area is located inside Arasbaran Protected Zone near Kaleybar. It is located mid-way along Kaleybar-Jananloo-Ashegloo-Kaleybar road (Figure 1). As a biosphere reserve, Arasbaran is extended over an area of 125,255 hectare in northern Iran, along Iran-Armenia and Iran-Azerbaijan borderline. Belonging to Caucasus Iranian highlands, this area was registered as a world biosphere reserve and wildlife refuge by UNESCO in 1976.In terms of geographical coordination, Arasbaran is located within 38°40 to 39°08`N and 46°39 to 47°02`E.This mountainous area is a part of Caucasian Mountains and is lifted to 256-2,896 m from sea level (Havaskary, Farshbaf et al. 2012).

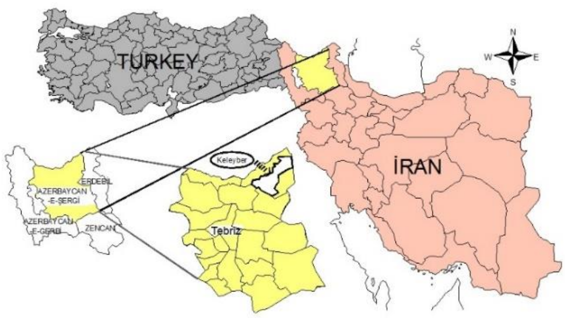


Figure 1. Location of Studied Area

2.2. Climatic Data

Arasbaran is affected by polar, Arabic and tropical weather in winter and Mediterranean, tropical and polar weather in summer. In terms of climate, the area is semi-arid in north, semi-arid but with moderate climate in the middle, and semi-arid with cold weather in the south. Annual total precipitation across the region is around 106,7 million m^3 and average precipitation across the region is 450 to 600 mm. The rainy season of the year is spring, with an average precipitation of 118,3 mm, while the driest season is summer within average precipitation of 31,7 mm. Also, average annual temperature across the region is 11.6°C. A total of 48 mammal species, 215 bird species, 29 reptile species, 5 amphibious animal species, and 17 fish species have been identified across the area. The most important species living in the area include pheasant, grouse, grizzly bear, wild goat, leopard, chamois, black stork, Alborz serpent, and francolin. Further, 26 tree and bush species and 20 meadow plant species have been recognized in the region. Dominant plant species include oak, cherry, ash, and some other species such as Yew Plantain, Wych, aras, walnut, pear, walnut, pear hawthorn, medlar, pomegranate, and quince (Rezaei, Jafarzadeh et al. 2015).

3. METHOD

For choosing suitable villages for study, after visiting the region and studying the status of rural houses from different points of view (e.g. construction date, used materials, construction techniques), the ancient and traditional villages were selected, as those well corresponded to villagers' needs, geographical location, and local facilities. Considering the mentioned factors, six villages were selected: Khan Khosro, Galusang, Kiyarag, Heydar Kanloo, Tatar Olya, and Kalale Sofla.

In order to evaluate vernacular architecture of Kaleybar area, two houses in Khane Khosro Village (types a and b) and one house in each of the other villages were selected. Galusang (type c), Kiyarag (type d), Heydar Kanloo (type e), Tatar Olya (type f), and Kalale Sofla (type g). The plan and section of the houses were prepared through field studies, author's measurements and interviews with local people (Table 1). Then, architectural specifications of the houses were extracted in terms of such factors as area, open spaces, semi-open spaces, opening (size-position, local materials used), foundation (width, height, and materials). Also wall (external wall width, internal wall width, wall type, mortar type, local materials, and wooden hasps), column (height, local materials used), and roof (local materials of main and secondary beams, local plant(s) used, coverage) (Table 2-4).

4. ANALYSIS OF VERNACULAR ARCHITECTURE AND BUILDING PHYSICS

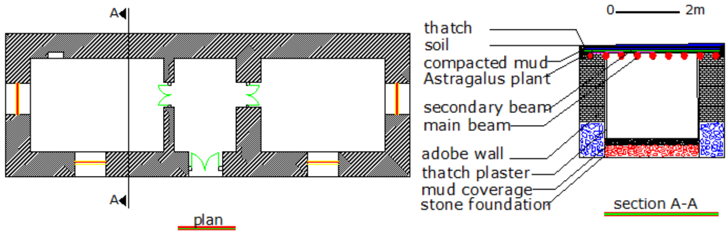
Kaleybar has large potentials for rural tourism development, and imperative infrastructures such as accommodation services, transportation and public facilities can be provided by local design recommendations. Local design recommendations can be incorporated into current architectural practice across the region. This paper evaluates vernacular architecture of the region, in term of building typology and building physics. These results can be used as an ecological pattern in sustainable development projects performed in the area in the future.

Area: Space dimensions in studied rural houses matched the villagers' dimension. Flexibility of the villagers was high. Such parts of the house as stairways, terrace, oven and alike were seen to be constructed to minimum dimension. Maximum area of an entire rural house rarely exceeded 100 m^2, although the houses belonging to the head of nomads (type e) were larger other villagers'. It should be noted that all of the studied houses were constructed prior to the 1979 revolution.

Open spaces: Due to climatic and topographic conditions, courtyard can be found in Kaleybar villages only in rare cases, so that social gatherings usually take place in semi-open spaces, public streets, alleys, or the village mosque.

Semi-open spaces: Although semi-open spaces allow for taking advantage of adequate solar energy during winter, but limited land availability and poverty of rural communities, semi-open spaces (e.g. balconies) were rarely seen in Kaleybar area.

Table 1 .Plan, Section, Description of Buildings

<table>
<tr><th>Appearance</th><th>Plan, section, Description</th></tr>
<tr><td>House a
</td><td>
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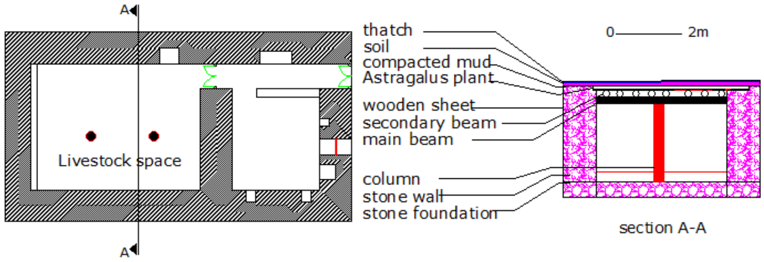
</td><td>
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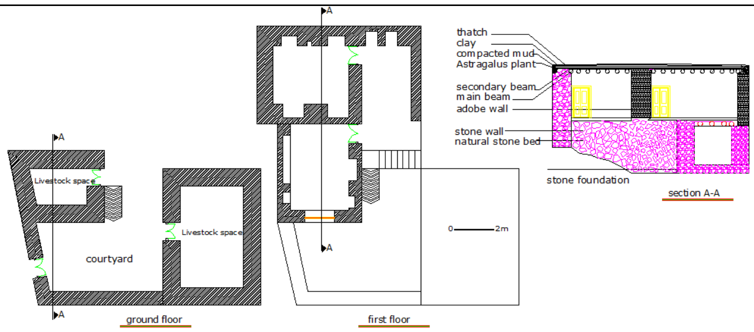
</td><td>
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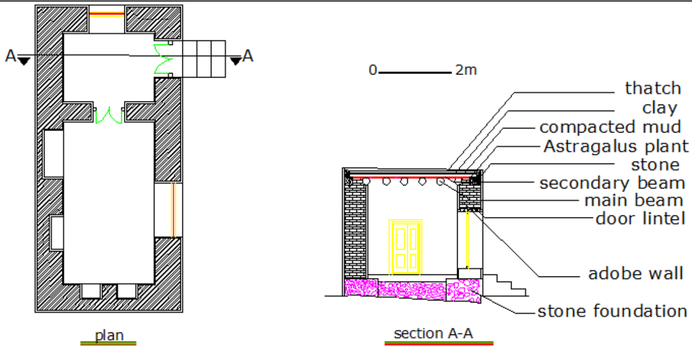
</td><td>
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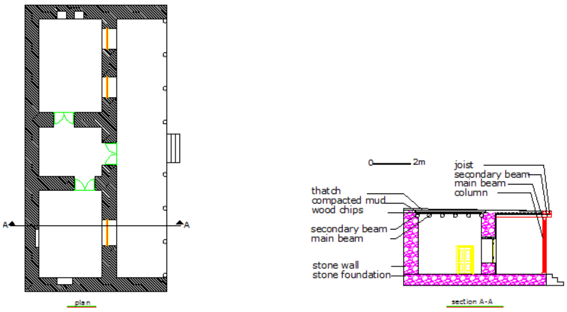
</td><td>
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Table 1. Plan, Section, Description of Buildings (continue)

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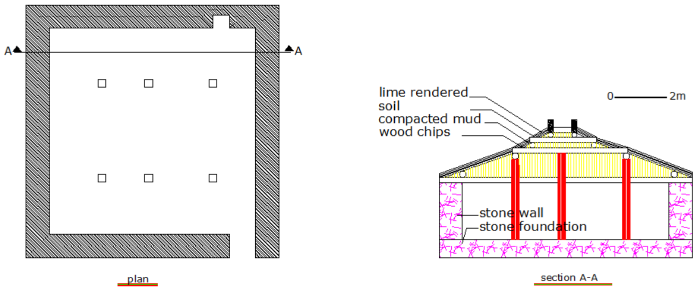
</td><td>
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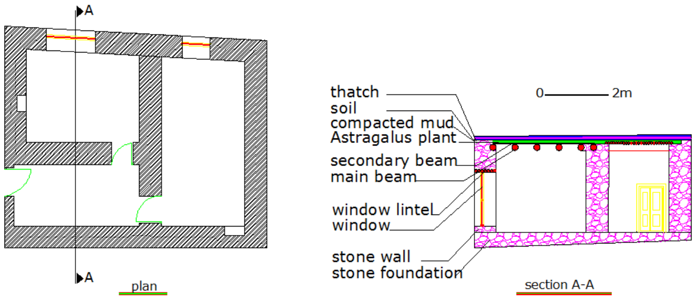
</td><td>
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Table 2. Evaluation of the Vernacular Architecture and Building Physics I

Types of houses	**Area (m2)**	**Open Spaces**	**Semi-open Spaces**	**Opening**		
				Size-position		**Local materials**
a	60	---	---	N: --- S: 4.35%	W: 11.60% E: 11.60%	*Juniperus excelsa, Salix alba, Juglans regia*
b	66	---	---	N: --- S: ---	W: --- E: 10.00%	*Juniperus excelsa, Salix alba, Juglans regia*
c	100	---	---	N: --- S: 5.10%	W: 3.00% E: 3.30%	*Juniperus excelsa, Salix alba, Prunus avium*
d	34	---	---	N: 5.00% S: ---	W: --- E: 18.00%	*Juniperus excelsa, Salix alba, Prunus avium*
e	116	---	Balcony at E side	N: --- S: ---	W: --- E: 15.30%	*Juniperus excelsa, Salix alba*
f	94	---	---	N: --- S: 5.40%	W: --- E: ---	*Juniperus excelsa, Salix alba*
g	57	---	---	N: 9.50% S: ---	W: 8.50% E: ---	*Juniperus excelsa, Salix alba, Carpinus betulus*

Table 3. Evaluation of the Vernacular Architecture and Building Physics II

Types of houses	Foundation			Wall				
	Width (cm)	Height (cm)	Materials	External wall width(cm)	Interior wall width(cm)	Wall type	Mortar type	Local materials of wooden hasps
a	80	110	Stone, mud	80	35	adobe	mud	*Juniperus excelsa*
b	120	40	Stone, mud	100	-	stone	mud	*Juniperus excelsa*
c	100	50	Stone, mud	80	65	adobe	mud	*Juniperus excelsa*
d	100	70	Stone, mud	80	60	adobe	mud	*Juniperus excelsa*
e	75	60	Stone, lime	75	75	stone	lime	*Juniperus excelsa*
f	90	60	Stone, lime	90	-	stone	lime	*Juniperus excelsa*
g	90	70	Stone, mud	75	75	Stone	mud	*Juniperus excelsa*

Table 4. Evaluation of the Vernacular Architecture and Building Physics III

Types of houses	Column		Roof				
	Height (cm)	Local Materials used	Thickness (cm)	Local materials of main beams	Local Materials of secondary beams	Local plant used	Coverage
a	-	-	40	*Juniperus excelsa Prunus avium*	*Juglans regia*	*Astragalus*	thatch
b	190	*Juniperus excelsa*	40	*Juniperus excelsa*	*Juglans regia*	*Astragalus*	thatch
c	250	*Prunus avium*	40	*Juniperus excelsa Prunus avium*	*Juglans regia*	*Astragalus*	thatch
d	-	-	40	*Juniperus excelsa*	*Morus alba*	*Astragalus*	thatch
e	320	*Juniperus excelsa*	40	*Juniperus excelsa*	*Juniperus excelsa*	*Astragalus*	thatch
f	220 ~ 470	*Juniperus excelsa*	40~ 90	*Juniperus excelsa*	*Juniperus excelsa*	*Astragalus*	thatch
g	-	-	40	*Juniperus excelsa*	*Carpinus betulus*	*Astragalus*	thatch

Opening: Climatological requirements represent the main determinant factor in specifying proportions, sizes and number of openings. Apart from low number of windows, small windows were seen as quiet common in this climatic region. The opening-to-wall ratio varied from 0.00% to 18.00%, with no opening in façade of more than half of the studied buildings. The use of few small openings served as a solution against cold regional climate. In addition, the location of openings were specified in such a way to prevent air flow. In the studied rural houses, either the main entrance door of the house was made of Excels wood, or this wood was used just in the lintel or threshold of the door, with the remaining part been made of *Juglans*, *Prunus avium* or *Carpinus betulus* wood. Lintel of the openings was made of *Juniperus excelsa* wood and the window frames were made of *Salix alba* wood, considering its light and bendable characteristics.

Foundation: After selecting suitable land of enough stability for construction, excavation operation for load bearing walls started. According to the soil stability state, the excavation continued to a depth of 60-110 cm in a width of 75-120 cm. Big stones from the river bed were used to make the foundation. In this area, in order to level the floor on irregular grounds and prevent the leakage of humidity into the house interior, the foundation was usually raised to 70-150 cm from the ground level.

Walls: Walls of vernacular rural houses in Kaleybar region were seen to be made of adobe (Figure 2), stone, or a combination of them. Adobe walls were mainly constructed with adobes of 25 × 25 × 7cm in dimensions (Figure 3).

Figure 2. Example of Adobe Wall

After removing the molds used to form the mortar, the molded mortar was exposed for 3-15 days, so as to become strong enough for subsequent construction operations. It should be mentioned that, in order to prevent adobe form cracking and increase its residence, some straw is added to its material. Adobe walls were covered with cob, which was made from subsoil, water and straw. It serves as an excellent insulation material in this cold region. Total thickness of the adobe walls reached 80 cm, with their maximum high never exceeding 3m.

Figure 3. Mortar Mold

In this area, river stone and mountain stone (commonly referred to as rubble stone) had been used to construct stone walls. River stones are used in small spaces or as infill materials, but rubble stones are suitable for construction of strong and long-lasting stone walls with mud or lime mortar. The used stones are often small and of different sizes. Total thickness of stone walls reached 100 cm. In most cases, *Juniperus excelsa* wood was used as horizontal wooden hasp to attach stone layers to one another against horizontal forces such as earthquake. The use of local materials such as stone and adobe and application of thick walls had minimized temperature exchange between interior and exterior space, because of high heat capacity and low heat transfer coefficient of the materials.

Roofs: As a common practice across the region, roofs were constructed as flat. These were covered with a thick layer of mud could transfer its weight to the wooden beams and then to the walls and columns when it is needs. Most of the villagers had used *Juniperus excelsa* wood to construct their houses' columns, due to its high resistance; in some cases, however, sweet cherry wood was used instead. In the studied houses, the main beams are made of local woods, such as *Juniperus excelsa* wood and *Prunus avium* wood, while secondary beams were made of local trees such as *Morus alba*, *Carpinus betulus* and *Juglans*. Moreover, a kind of local plant, *Astragalus*, was also incorporated into roofs to prevent secondary beams and the mud on the roof from coming into contact (which can end up with damaging the members) and also to prevent the entrance of insects. Keeping some snow on the flat roofs on which a thick layer of mud was applied, acted as thermal insulation in cold climate.

The next roof type was wooden roof (type f) (Figure 4).These roofs were older than the previous ones. Considering the changes in occupants 'lifestyle during many years, this type of roofs is rarely seen in this area. *Juniperus excelsa* timbers were the main constituents of these roofs. These wooden roofs covered the square-shaped houses. The first line of roofs were supported with legs, and rafters had given a smaller square shape to the space. The second line was fixed over the first line and shaped like a square space of smaller size than that of the first line. Finally, this elevating trend ended up with shaping square holes through which light and also ventilation could be provided (Figure 5).

Construction materials: Most of constructions across the region are performed using local materials. Being abundantly available, reusable and recyclable, local materials have low impact on the environment and contribute to local economy (Mehta, 2010). Local material used in the studied rural houses included the followings:

- Soil: it is the main material used in the rural constructions. The choice of suitable soil depends on the type of use. The soil was used in the form of adobe, mortar and cob in the studied houses.
- Stone: since the region is mountainous, stone can be found plentifully. In these villages, stones were used in two forms: river stones and rubble stones. Of course, there were cases where Malone stone was used.
- Wood: having various gardens, wood could serve as a construction material for local people. Local trees such as *Juniperus excelsa*, *Prunus avium*, *Salix alba*, *Juglans*, *Carpinus betulus*, and other local plants such as Astragalus were seen to be used in the rural houses *Juniperus excelsa* was the main timber material in use. It is mostly found in mountainous forests of Kaleybar region and extensively available in the area, indicating its resistance against the regional ecological conditions and cold and dry weather.

Figure 4. Example of Wooden Roof.

Figure 5. Roof Hole.

5. DISCUSSION AND CONCLOSIONS

This paper was an attempts to reveal the secrets incorporated into a few of eco-efficient rural houses in Kaleybar area. The most important specifications of the rural house included; compatibility with regional texture, its formation based on land form, organization of different spaces considering the family lifestyle, climatic factors, and social and cultural conditions of the people. Rural houses in Kaleybar area demonstrated an economical use of local building materials and low-energy design principles by being climatically responsive. These design recommendations can be replicated not only to respect traditional values, but also to take advantage of its essential ecological and financial benefits as it has been accessed by local people through a prolonged trial-and-error process. These design recommendations can be utilized in today’s architectural practice in the area. While sustainable architecture needs environment-friendly buildings, which do not harm the environment.

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