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Sustainable Development and its Concepts in Rural Residential Spaces of Sistan, Iran

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Abstract

Today, economizing on fuels and sustainable development are the most important cases in common international challenges. Energy saving, decreasing in expending oils and coexisting with the earth, are the most important measures in sustainable development. Because, consuming fuel in residential spaces is one of the most effective factors in earth pollution, concepts of sustainable development had been extended to the architecture and urban design. The author`s results from field study in the area with the aim of "sustainable architecture of Sistan" carrying out from 2012 to 2014 proves that some of measures which had been used in rural environment and residential spaces of Sistan, have contained most of new concepts in field of sustainable development. This research also indicates that the rural architecture of Sistan has not improved in comparison with other parts of Iran but has achieved special features which can follow concepts of sustainable development in field of rural environment and residential spaces of Sistan , too.

Key words: sustainable development, local architecture of Sistan , environment, home

Introduction

Texture and indigenous housing in most regions, entirely adapt with environment, dwellers' demands and especially climatic. Rural buildings benefit from form material, and building's orientation connected to sun reflection and wind. Additionally, due to minimum need of alternative sources of energy for producing heat and cold, they provide relatively comfortable condition for their inhabitants (Jalilian and Tahbaz, 2002:2).

Contemporary architecture that is based on modern architecture's paradigms and regardless climatic characteristic needs fossil energies. Analytic statistics between 1997 to 2007 proves that in 1997 domestic energy consumption over the country is 30 percent (Iranian Fuel Consumption Optimizing Organization, 2010, 2-4) also, in this decade, on average, consumption has increased 6.05 percent in comparison with previous year (Jalilian and Tahbaz, 2002). Apart from this, energy consumption in domestic part are followed as below:

A) Lighting: 25 percent
B) Cold and heating: 45 percent
C) Facilities and equipment: 15 percent
D) Energy waste: 15 percent (Mofidi. 1998, 14)

These statistics prove that domestic energy consumption includes 30 percent of the country that 15 percent of this total is wasted and 70 percent is used in lighting, heat and cold. This must end up to plan energy consumptions again. Considering this point, rural areas with limited resources, relatively low level of life style, far away from cities facilities and difficult access have increased the importance of economizing energy (Jalilian, Tahbaz, 2002: 2). To achieve this purpose, some concepts such as sustainability and its relation to construction are fully noticed:

A) What kind of impacts do climatic characteristics leave on rural and housing texture?

B) How should local materials and renewable sources of energy be applied to rural architecture of Sistan with respect to climatic conditions?

Literature review

In order to present the current theories related to energy consumption and saving in indigenous housing and texture, some of points of views and ideas are discussed:

Jalalian and Tahbaz, in their article named "*saving energy consumption in rural housing of Dasht-e-Moghan*", apart from recognizing and analyzing indigenous architecture of the region, the current ways in construction and examples of sustainable architecture and architectural solutions have been gathered

Also, Zandiyeh and Parvardinejad, in their article, "*sustainable development and its concepts in Iran's residential architecture*" presented the climatic techniques in Iranian housing and resulted that vernacular architecture would be a proper pattern for current architecture.

Finally, Khodabakhshi and Mofidi, in their research named "*sustainable construction related in Iran's vernacular architecture*" after reviewing previous researches, gathered all theories and studies and analyzed vernacular features in four distinct climates with respect to case studies

Theoretical framework

Regarding various researches conducted in sustainable construction related to Iran's vernacular architecture, it is worth mentioning that most of these researches are focusing on Iran's main climate or the importance of energy in building and the quality of benefitting from renewable energy but in those scholarly works, micro climates such as Sistan where is located in hot and arid climate and wind of 120 days have been ignored. Therefore, in this research, along with mentioning main principles for hot and arid climate, the especial characteristics of Sistan's rural texture and housing precisely will be considered.

Hypothesis

H1: Optimum use of renewable energy such as wind, sun in previous construction is reviewed.

H2: The vernacular architecture of the region leaves the minimum negative impacts on environment and ecosystem.

H3: Respecting what mentioned above, the vernacular architecture of Sistan followed sustainable principles.

Methodology

Defining some concepts such as sustainability and its relation with construction in rural areas are followed with climatic features. This stems from housing typology, influenced by environmental, climatic and cultural paradigms Also new architectural problems of rural areas, caused by inharmonious material, improper designing and lack of energy saving and destroying environment are discussed and finally some solutions for saving energy are presented. To do this, analytic and research method is combined with field, documentary and statistic studies.

Reviewing vernacular construction of Sistan rural areas with respect to sustainability

Sistan Climate

Sistan region with an area of 15,197 square kilometers in the geographic area between 60 degrees and 15 minutes to 61 degrees longitude and 30 degrees 50 minutes and 5 minutes to 31 degrees 28 minutes latitude is located. The North and East, Afghanistan, South West and North West of the city of Zahedan city.

Table 1. Climatic characteristic of Sistan

Region	Climate	Annual average temperature	Annual average raining	Annual average humidity	Annual average of freezing days	Annual average of days above 35 degree
Sistan (zabol)	Hot and Arid	22.3 centigrade	59 millimeter	39	17	155

Source: Research Center of Applied Forecast of Sistan and Balouchestam, , Drought Climatology Research Group (2010)

Table 2. Methodology in climatology

Continuous Multivariate Methods	Kopen method	*Hydrothermal. Coefficient.* Selianinov,	*IVANOV coefficient*	Demarten coefficient	Region (City)
Hot and arid	Semi dry	Desert climate	Desert climate	Dry climate	Sistan (zabol)

Source: Research Center of Applied Forecast of Sistan and Balouchestam, Drought Climatology Research Group (2010)

According to table 1 and 2, the main characteristics of the region include low raining, high temperature, strong winds and dust hurricane (wind of 120 days) and utterly hot and arid climate. Of course, Hirmand River, Hamoon natural lake and fertile lands help moderate these conditions. In general when Hamooun and Hiramand are not suffering from drought, Sistan climate is considered as mild hot and arid climate (Drought Climatology Research Group, 2010, 3-1)

The etymology of Sustainability

In Dehkhoda encyclopedia sustainably is defined as durable and in Moein encyclopedia its root “Payesh” meaning to resist (Dehkhoda Encyclopedia, 47) Sustain has a Latin root “ Sustinere” and compose of “Sus” (from bottom to up) and “Tinere” (maintain and conserve) and has been used commonly since 1290 A.D. This verb is combined with some concepts such as support, consistency and “Sustainable” is describing something that is supported or due to help, has remained.

Sustainable development and its definitions

Sustainable development has been used in mid-70 and after petrol crisis in 1973 are repeatedly used. The main definition, submitted in Rio conference is” a kind of development can fulfill man demands without jeopardizing the demand of future generation.” Although various definitions for sustainable architecture have been presented but most attention has focused on further generation, the future of environment and conservation. Respecting culture, indigenous features previous experiences and benefitting from renewable sources of energy and avoiding none-renewable source of energy are the principles of sustainable architecture (Hatami Golzari, 2008). According to UN definition, sustainable architecture is “a kind of development can respond current demands without impacting on capability of further generation for supplying their needs”. “World Bank” defines sustainable development as a kind of development that continues (Azizi, 2001).

Definitions for sustainable architecture

Sustainable architecture dates back 19 century. The purpose of designing sustainable architecture is to decrease damages on environment with respect to energy and benefitting from natural resources that include the principles below:

A) the reduction of none-renewable energy resources
B) Development of natural environment
C) elimination or reduction of using poisonous materials or dangerous for nature in building industry

Based on “OECD”, sustainable buildings are those which have the minimum damage on natural built environment, their surroundings and the total context. Sustainable buildings pay attention to proper function, the quality of environment and future. The principles of sustainable architecture are:

1) energy saving
2) climatic
3) reduction in using resources
4) providing dwellers demands
5) adapting with site
6) totalism

Paradigms of sustainable architecture

The main purpose of a sustainable architecture is to reduce the negative impacts of building on environment regarding proper efficiency. A sustainable designing simultaneously is seeking for aesthetics, environmental, social, economic, Moral and spiritual values. Therefore, sustainable architecture helps create a healthy environment based on preserving none renewable resources, reduction of consumption renewable resources and promoting the quality of environment (Hatami Golzari, 2008). In Other words, a sustainable architecture is a kind of architecture that benefits the most from environment for its users and applies wise solutions. Additionally, it minimizes improper construction, buildings should respond well to new condition and not to confront with nature (Ahmadi, 2002: 94).

The main principles in hot and arid housing and texture that provides natural comfort in most of the time and minimizes the fossil energy are a suitable pattern for sustainable concepts in construction (Tavasoli, 2002: 116-119). Some of these principles include as follows:

- Building city and village compact and full of shade
- Preventing sun penetration
- Constructing passages in direction of wind
- Preventing hot, sandy and stormy wind with planting
- Planting in yard and public spaces
- Stretching the building in east-west axis
- Considering semi open spaces such as Iwan
- The flexibility of interior spaces
- Applying local materials with high thermo capacity
- Domed roof
- Construction eaves
- Creating circulation in spaces.

Sistan rural vernacular features

In this part, apart from presenting the architectural characteristics of rural areas in Sistan region, these features are discussed with respect to the main principles of construction in hot and arid climate.

1)Rural areas in Sistan have a compact texture

Figure 1: Galeno village in Sistan (2009) (Source: author)

In hot and arid climate, plan must be compact in order to have minimum surfaces against sun (Khodabakhshi, Mofidi, 2001, 608).

2)As it is seen in figure 1, openings of rural architecture has been minimized to prevent sun entering interior spaces. Studies show that the surface of windows in east, west and south are at most 15 percent of room area and if double shield windows are used, this area can increase up to 30 percent. (Baker, 1996, 17)

3)In order to benefit from northern wind and also sun, the area is east-west. (Figure 1 and 2) Eastern-western orientation results the maximum use of solar energy in winter and the minimum sun radiation in the summer (Naghizadeh, 2002, 10)

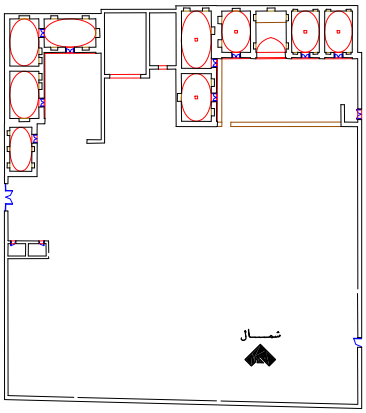

Figure 2. Residential plan, Galeno village (source: author)

4) Constructions in Sistan are L shaped and in face south and east (Figure 1) or one sided and face south (Figure 2).

Choosing forms that create shade in summer and absorb maximum sun radiation in winter has a great influence on saving energy. These forms are parallel ones (One sided). Perpendicular (L shaped) and three sided (U shaped) and of course all faces south. (Naghizadeh, 2002, 14)

5) The behavior of residents in a building can make the energy consumption double. (Baker, 1996, 6). Due to shortage of resources, people utilize the minimums, their houses are simple and the minimum spaces and decoration are the common characteristics of rural architecture in Sistan. The structural decorations are used rather than joining decoration (Fig 1 to 5). Different spaces have flexible functions and overlap each other during the day (Field study)

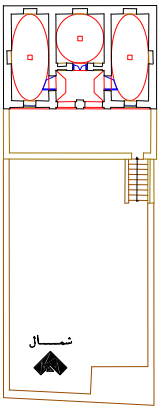

Figure 3. Residential plan, Ghaleno village (Source: author)

6) Vernacular architecture in Sistan is included confined, semi confined and open spaces. Semi confined spaces, roofed Iwan and corridors, ended confined spaces (Fig 1) can create circulation and reduce the sun radiation in summer, also they can let sun penetrate interior spaces in the winter (Zandiye, 2010, 19). The more usage of open spaces such as roof, yard, terrace is another way for energy consumption, these spaces during sunset and night in the warm seasons , when the interior spaces are still heated can make a nice atmosphere for dwellers.

7) Another architectural characteristic of the region is tall walls and ceilings (Fig 4,5). In addition, tall walls can create shade (Tavasoli, 2002, 116) and domed roof are used for cool air in interior spaces. Because of significant heights, arced vault and domed shape in hot and arid climate can create vertical ventilation by sinking cold air and rising hot air. This feature can be made by installing a vent on ceiling (Gobadian, 2008, 141)

8) The abundance of clay as a component of adobe and reed help constructors use them in vernacular architecture. Sometimes, local people make the shelters with these materials alone. The common used materials in exterior walls are adobe, clay and sometimes brick (Fig1-5), using proper existing material in the region shows their climatic function. It is important to know that using local materials can reduce expenses (Zandiye, 2010, 18).

9) One of the eye-catching features in Sistan vernacular architecture is wind tower named" Kolak". The majority of vernacular architecture have wind tower, these are short, one sided and entrance. These particular shapes develop from high speed Sistan winds. The entrance has 70 centimeter high and 40 centimeter length. This shape along with interior hole can create circulation when the wind stops (Gobadian, 2008, 141).

Figure 4: Sistan region wind tower (Source: author)

10) In hot and arid climate, evaporation can reduce temperature. (Zandiye, 2010, 10). In Sistan vernacular architecture, due to lack of Sardab (crypt), Abnama (big pond) and Qanat and also make hot and dry wind humid, make a hole in the middle of yard and fill it with straw, This system is called kharkhane that create cold weather caused by evaporating water in straw inside house. (Razjouyan, 1988: 41)

Figure 5: Example of Kharkhane in Sistan region (Source: author)

11) One of the formal characteristics in Sistan vernacular architecture is latticed parapet. These parapets can provide protection, circulation and beautiful perspective and view (Tavasoli, 2002, 119).

Figure 6: Example of latticed parapet (Source: author)

12) Domes in Sistan can be developed on a rectangular basis. (Fig 5). One of the main characteristic of climatic dome in hot and arid region is vertical ventilation that cold weather sinks and hot weather rises up. This feature with aid of vent in wind tower can create vertical ventilation.

Figure 7. Example of Sistan domes with rectangular plan (Source: author)

The characteristics of rural area in Sistan prove that in past construction, efficient use of renewable source of energy such as circulation and sun have been intelligently considered.

Also, vernacular architecture of region with respect to local material leaves the least impact on environment. The comparison between rural architecture of Sistan and main principles of sustainable architecture and the regulation of designing texture and housing in hot and arid climate proves that these rules have been applied in Sistan vernacular architecture and this kind of architecture is a sort of sustainable architecture.

New characteristics of newly architectural way in Sistan

A general analysis on new construction in Sistan along with intelligent vernacular architecture depicts a big and huge contradiction. Housing is made by concrete, iron, brick; short walls in yard cannot create shade and protect building against strong wind and sun radiation. Additionally, applying thin ceiling causes improper resistance. Usage black tar on roofs results increasing heat in the summer and reducing temperature in the winter. Finally, applying heating systems with fossil fuel and cooling system entire year implying that this improper method make residents uncomfortable and do not respect sustainable architecture (Khodabakhsi and Mofidi, 2001, 609).

Solutions for designing rural housing with approach to sustainable architecture in Sistan

In sustainable point of view, Sistan is worth discovering. The basis of Iran's architecture inspire of nature and its forces (light, water, wind, soil) and it is strongly contextual, land-oriented and detachable part of environment (Ahmadi, 2003: 96). On the other hand, all sustainable architecture principles in a complete process that ends up a healthy environment are developed (Soflaei, 2003, 153). According to conducted studies and recognizing demands and problems that exist in rural architecture in Sistan region and the applied solution in vernacular architecture including codes, the volume of building, open and. semi open and confined spaces, openings, windows, walls, materials and technology, the following are recommended:

- The recommended texture is a compact texture. Regarding big areas in rural housing, compact texture should be respect at least in one surface of the building
- The openings on façade should be minimized and distributed properly. The amount of window surfaces in east and west should be 15 percent of room area and if double shield windows are applied, this amount can increase up to 30 percent.
- In order to benefit from northern wind and sun light, it is recommended that the architecture of the region is on eastern-western axis.
- Residents' behavior can make the energy consumption double
- The installation of semi confined, roofed iwan, and corridor ended confined spaces can create circulation and reduction of sun light in the summer and let sun penetrate interior spaces in the winter.
- Applying tall walls for creating shade and high ceiling for making confined spaces cool
- Applying clay as it was used in vernacular architecture is forbidden according to 2800 code. Considering the valuable soil in the region, conducting some researches for optimizing clay and producing new materials that have some characteristics such as locality, proper insulation can save transport expenses and save energy.
- Designing a proper wind tower with climatic features inspiring by Kolak can provide comfort and beautiful.
- Cold produced by water evaporation similar to Kharkhane system can produces cold and destroy dust.

- Building latticed parapet on roofs
- Planting local and resistant trees in neighborhood, yard and public spaces can moderate the weather and prevent dust.

Conclusion

Vernacular architecture of Sistan has not followed the other types of architecture but it has valuable features that can be used in the constructions. The localization of these features in rural areas can improve and revitalize the appearance of region and create the sustainability. Also, special wind tower named Kolak and Kharkhane prove that wind is an essential item for producing comfort for residents against heat.

References

Ahmadi, F. (2003). Sustainable architecture, Abadi Magazine.

Asadpour, A. (2006). Sustainable paradigms in Iran's desert architecture.

Baker, N.V. (1996). Energy and Environment in Non – Domestic Buildings , Cambridge Architectural Research Ltd, University of Cambridge.

Ghisvand, J. (2006). The interaction between architecture and new energies, Rah and Sakhteman magazine, 38.

Gobadian.V. (2008). Climatic analysis on Iran's vernacular housing, Tehran University publication.

Hatami, E. (2008). Iran's vernacular architecture and sustainable development, engineering magazine of infrastructure.

Jalalian.S, & Tahbaz.M. (2002). Saving energy consumption in rural housing,

Khodabakhshi.S, & Mofidi.M (2001). Sustainable construction related to Iran's vernacular architecture, National Committee of Energy of Islamic Republic of Iran.

Mofidi, S.M. (1998). Climatic Urban Design, PhD Dissertation, University of Sheffield.

Naghizadeh, M. (2002). Architecture and urbanism codes, second conference of fuel optimization.

Pinia.M. (2001). Introduction to Islamic architecture, Tehran, Science and Technology publication.

Razjooyan, M. (1988). Comfort by architectural harmony with the climate, Tehran: Shahid Beheshti University.

Soflaei, F. (2003). The suitability of climatic elements in Iran's vernacular architecture (hot and arid climate).

Tavsoli.M. (2002). Building the city in hot and arid climate, Payam publication

Zandiye.M, & Parvardi.S (2010). Sustainable development and its concepts in Iran's residential architecture. Housing and Rural Environment, 130.