

Study of Environmental Sustainability & Green Building in Iran's warm/dry weather Using LEED

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ABSTRACT— In the past few years, the Iranian Green Management Association has attempted to import the latest modern knowledge with a green approach to Iran. In this regard, the board decided to develop the international building rating systems in Iran to achieve green buildings and sustainable environment in the country. Among these systems, LEED rating system could be noted that provide seven items for rating a building. Among the items are "sustainable sites" subsets of which include: erosion and sediment control, site selection, development density, redevelopment of contaminated sites, alternative transportation, reduced site disturbance, storm-water management, and heat island effect and light pollution reduction. The purpose of this paper was to draw architects' attention to the use of this type of rating systems for sustainability and preservation of the environment. The analogic-analytical method was applied and subsets of "sustainable sites" were analyzed and compared with the current situation in the region and how these systems help the urban order and sustainability. The results of this paper showed that the use of this type of rating systems, however little, is very important for environmental and building sustainability. Moreover, given the Iranian climate and population differences compared to the LEED founding countries, the points of "alternative transportation" has to be far more than "development density".

KEYWORDS: LEED, dry weather, Sustainable Site, Alternative Transportation, Environmental Sustainability.

Introduction

Destruction of natural resources, environmental pollution and consequently a risk to human life on earth as the only ecosystem, inappropriateness of many development plans that cause a lot of natural resources destruction and environmental pollution have led societies to develop plans with environmental sustainability approaches. In this regard, many groups were aimed to design a system that can rank the adherence of buildings to environmental sustainability and their compliance to the region's green space and climate. [1] The purpose of the stability calibration system is to reduce the damaging effects of buildings on environment, increase the useful life of the building and its components and finally their return to the nature to be able to help classify buildings based on their environmental sustainability and offer them a certificate as an evidence for adherence to the principles of environment sustainability. [2] Among the rating system, LEED could be noted. LEED is a green building rating system which was initially signed as a licensing agreement between the Canada Green Building Council (CAGBC) with the U.S. Green Building Council (USGBC) for the exclusive implementation of the LEED green building rating system in Canada. [3] LEED includes seven items for building rating. Among the items are "sustainable sites" subsets of which include: erosion and sediment control, site selection, development density, redevelopment of contaminated sites, alternative transportation, reduced site disturbance, storm-water management, and heat island effect and light pollution reduction. Additionally, considering the climate, natural resources and natural-regional hazards in the founding countries of LEED, there are commonalities as well as differences between the level of accordance of each items of LEED with natural resources and natural-regional hazards in regions like Iran, especially central and southern regions that have hot and dry and sultry climates.

Statement of the Problem

Examining all of the standards and requirements outlined in the LEED system and comparing these standards with the standards and requirements for buildings in hot and dry or hot and humid regions in Iran, it is observed that some of the prerequisites and standards are not coordinated with design standards in Iran, especially in central and southern parts. Given that in this research only the item of "sustainable sites" has been studied, as a result the subsets of this item are discussed in comparison with the current situation in Iran. The question of the research focuses on how to earn points for the sustainability of a building in connection with the specific environment of Iran and compare the importance of rating the item that comply with the LEED designer countries. Therefore, for rating this type of buildings in terms of the climate in the region, alternative prerequisites should be selected or points for each item and its subsets should differ according to climate differences.

Research Methodology

The research methodology of the current study is based on a comparison of the principles contained in the subsets of "sustainable sites" with building design principles in southern Iran which date back far beyond LEED and also the analysis of these comparisons using library studies, regional cases and observations. More precisely, reasons of considering the differences in the scores, especially in "alternative transportation", "heat island effect" and "development density" with respect to the LEED standards are discussed.

Theoretical Principles

Traditionally, buildings were constructed using materials available in the same area. First, this was mainly due to the lack of transportation of building materials from other areas. Second, the materials that were used in the same area were certainly compatible with the environment of that area and could mainly meet the needs of the region. Therefore, the first point in the design of buildings in every area is to consider the climate of the region. Recognizing the importance of the climate of each region, from the past to the present, has been a major priority of architects and climate-adaptable architecture in each region is the main principle applied to reduce costs such as transportation and production of materials and increase the environmental sustainability of the region. With this type of architectural design, necessary coordination is established between man-made environments and perimeter natural environments; thus, by minimal cost and maximum coordination with the regional climate, human comfort conditions are provided. Over time, seeking the comfort zone¹, human imposed transformations on the environment through applying new materials, importing materials from other parts, using the transportation systems, so far as in the last century, intense interference and influence on the nature, the specific environment and ecosystem of each region have led to imbalance. Industrialization and air pollution, rapid population growth and irregular urban development with an impact on the environment have created challenges for conserving environmental values. Nowadays, irregular population growth, development without urban planning, green-houses gases emissions, pollution from fossil fuels, acid rain from air pollution, climate change, ozone hole, global warming, and the like cause concern for many people.[4] Thus, due to the destruction of natural resources by abundant human exploitation of the nature and scientists' ineffectual efforts to find the possibility of life on other planets have caused environmental problems to precede other approaches and urban managers direct their efforts toward the development of environmental sustainability and green buildings. Therefore, macro-policies of any country in the various economic, social and cultural sections can directly and indirectly influence the environment and also take effects from the conditions in the environment. Accordingly, the LEED rating system was used and urban managers and architects began to assess, rate and design buildings based on these seven items. In fact, through its use as a design guideline and third-party certification tool, LEED aims to improve occupant well-being, environmental performance and economic returns of buildings using established and innovative practices, standards and technologies. Based on the ranks and complying with prerequisites in the LEED system, points add up to a final score that relates to one of four possible levels of authorized certification: LEED certified, silver, gold or platinum. The first item in this system is "sustainable sites". This item includes one prerequisite and eight credits, for rating buildings with a total of 14 points:

Prerequisite: Erosion and Sediment Control

This is a necessary prerequisite for approval of points for other credit of this item, so that if a building can receive these eight credits, it cannot receive any point without observing the prerequisite. The intent of the prerequisite is to control erosion to reduce negative impacts on water and air quality. According to LEED, a sediment and erosion control plan specific to the site shall be designed. The plan shall meet the following objectives:

- Prevent Loss of Soil during Construction by Storm-Water Runoff and/or wind Erosion: including protecting topsoil by stockpiling for reuse. The point is that considering the climate in southern Iran that has strong and frequent winds, soil erosion is mainly occurred due to neighboring the sea and unoccupied desert with no vegetation. Moreover, due to lack of appropriate drainage systems and its flow in the urban areas, this objective must be seriously followed in construction of buildings in this area.

- Prevent Sedimentation of Storm Sewer or Receiving Streams.

Using new urbanism methods, including collection and disposal of sewage and when financial sources are available, this system can be applied because of positive health, environmental, safety and sanitation aspects. The sewage system involves collecting wastewater from construction sites and transporting it to the disposal point. Basically, liquid waste should be treated before disposal in the water. Disposal of waste should not endanger public health.

- Prevent Polluting the Air with Dust and Particulate Matter.

In this case, due to the existence of vast areas of desert in central Iran and blowing Monsoon winds, especially in provinces such as Sistan and Baluchestan, Kerman, temporary or permanent plans should be developed to control this problem. Using strategies such as seeding, earth dikes, silt fencing, sediment traps and sediment basins, and the like will help prevent and control this problem.

¹ Comfort zone is climate in which human feels comfort physically in terms of thermal conditions and relative humidity[5]

Site Selection

The main intent is to avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site .

To obtain a score of 1, buildings, roads or parking areas on portions of sites that meet any one of the following criteria should not be developed :

- Lands That Are Part of a Provincial Agricultural Land Reserve or Forest Land Reserve
- In this regard, given the climate of southern Iran, this criterion is of great importance; since some of these areas have unsuitable soil for farming and planting, destruction of such low value of the land contributes to the destruction of the environment and green space .
- Previously Undeveloped Lands, the Elevation of Which Match the Elevation of the 100-Year Flood Plain or the Elevation of the 200-Year Flood Plain
- Ecologically Sensitive Lands
- In this case, the margins of the Oman Sea and the Persian Gulf because of coastal protected areas, wildlife shelter and wetlands can be noted which include these criteria .
- Lands That Provide Habitat for Rare or Endangered Species.
- Lands Which Prior to Acquisition for the Project Were Public Parkland, unless Lands of Equal or Greater Value as the Parkland Are Accepted in Trade by the Public Landowner

Another point that should be added to this section in Iran is to locate the correct site for implementation of the project. In Iran, location is a problem with no appropriate position so far among architects, urban planners, and managers and just in the last few years, some urban managers have paid attention to it. Points could also be considered on this subject .

Development Density

Its intent is to establish a communication channel with urban areas through applying existing infrastructure, protecting green-fields and preserving habitat and natural resources. In this regard, since the LEED designer countries have large population and less land with respect to their population and given the climate difference in those countries, the LEED regulations encourage architects and officials to increase development density and reduce the project effect area to maximize natural resources and green space protection, while due to climate differences in southern Iran as well as the extent of non-green available land for construction, this item is not applied and contrary to the provisions of LEED, building plans in this region of the country are broad due to the extreme heat and cultural factors .



Figure 1: An example of density of buildings in hot and dry and hot and humid areas of Iran

Among the strategies presented in this credit, preference is given to urban sites. Additionally, due to density and compactness of the buildings and districts in hot areas of Iran, this could be beneficial; however, in terms of surrounding urban land use that are not included in green spaces and by compliance with other principles, such as protection of ecosystems, lands other than urban lands could also be selected. Residents of hot and dry climate generally face serious problems such as severe exposure to sunlight, heat, dry air, lack of rainfall, low water, lack of humidity, dust and sand storms and temperature differences between day and night. Therefore, the density of buildings in different regions of the LEED designer countries is such that urban sets are dense and high levels of infrastructure is observed .

Redevelopment of Contaminated Sites

The intent is to rehabilitate damaged sites, where development is complicated by real or perceived environmental contamination and reduce pressure on undeveloped land. According to the LEED regulations, contaminated sites should be developed and remediation, as required by provincial contaminated sites program, should be provided. During the site selection process,

preference is given to previously contaminated sites, tax incentives and property cost savings are identified and a site remediation plan is developed and implemented using strategies such as pump-and-treat, bioreactors, land farming and in-situ remediation .

Alternative Transportation

In the LEED rating system, it has a maximum of 4 points and in the manufacturer states of the LEED, after the first prerequisites, it is the second most important condition .Compared with other methods of transportation, the use of personal cars is associated with more speed and comfort for the user; however, damages imposed on the society due to dependency on personal cars in long term has drawn attentions to emphasis on and replacement of more accurate planning, regarding the role of personal vehicles in the urban transportation. Car dependency problems in various social, economic and environmental aspects are shown in table 1 . [6]

Table 1: Problems of vehicle dependency [7]

Social	Economic	Environmental
Destruction of street life Loss of community Loss of public safety Isolation in distant countryside Difficulty of those with no access to vehicles as well as the disabled	External costs of accidents and pollution Compaction costs in spite of constructing roads High infrastructural costs in new diffused countryside Loss of fertile rural land Destruction of the urban land by bitumen	Oil vulnerability Petrochemical fumes Toxic emissions such as lead and butane gas High contribution of greenhouse gases Urban diffusion Problems of water storms above the level of highly violent water Traffic problems such as noise pollution and traffic separation

Personal cars and in general motor vehicles are the basic issue related to air pollution that produce carbon dioxide emissions as the main air pollutant. Thus, to better protect the environment, it is essential to minimize the use of pollutant vehicles and this is fulfilled with the help of options such as "alternative transportation". Use of public transportation such as subways, buses, tramways or even taxis instead of personal cars, use of cars with alternative fuel or hybrid vehicles or bicycles are important for proper implementation. Therefore, attention and emphasis on the "alternative transportation" should be much higher according to the condition of regions .

- Public Transportation Access

It aims to reduce pollution and land development impacts from automobile use. For this purpose, according to the regulations, the building should be located close to a commuter rail, light rail or subway station or at least two frequent offering services. Due to the current facilities in southern Iran, where no subway or railway exist, the only remaining option is the public bus lines which should be considered for construction .

- Bicycle Storage and Changing Rooms

According to the regulations, for commercial or institutional buildings, secure bicycle storage, with convenient changing/shower facilities should be provided for at least 5% of regular building occupants. For residential buildings, covered storage facilities for securing bicycles for 15% or more of building occupants in lieu of changing/shower facilities should be provided .After walking, cycling is known as a clean transportation method due to characteristics such as cost-effectiveness and higher mobility and at the same time is considered as an exercise for individuals. For example, Amsterdam and Copenhagen are both concerned with highly promoting cycling among their citizens. Special lanes with high-quality design along main roads, in parks and gardens, etc. (not merely for fun) have helped enhance the role of the bicycle in urban transportation system .[6]



Figure 2: The importance of the cycling culture in Amsterdam and Copenhagen

• Hybrid and Alternative Fuel Vehicles

Its requirements include :

- Provide high efficiency hybrid or alternative fuel vehicles for 3% of building occupants and provide preferred parking for these vehicles and highly efficient fuel-efficient vehicles .
- Install alternative-fuel refueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fuelling facilities must be separately ventilated or located outdoors .
- Among the strategies are providing transportation amenities such as alternative fuel refueling stations and carpool/vanpool programs and considering sharing the costs and benefits of refueling stations with neighbors .
- Parking Capacity

According to LEED, parking capacity should be sized to meet, but not exceed, minimum local zoning requirements. The intent are to minimize parking lot size and, as a result, to obliged people to use public transportation in lieu of personal vehicles . In this case, what is observed in southern Iran is the shortage of parking and even in some towns, lack of parking. Thus, people are accustomed to the lack of enough space for parking and park their cars in the immediate place in streets. Therefore, the traffic organization can prevent this by promoting acculturation to force people to use public transportation .

Reduced Site Disturbance

It intends to conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity. This credit has two points :

- Protect or Restore Open Space

Limiting site disturbance on green field sites, including earthwork and clearing of vegetation and limiting compaction in the constructed area could be noted .

- Development Footprint

In this regard, the development footprint (defined as entire building footprint, access roads and parking) should be reduced to exceed the local zoning's open space requirement for the site by 25%. Strategies include stacking the building program, tuck-under parking and sharing facilities with neighbors, establish clearly marked construction boundaries to minimize disturbance of existing and restore previously degraded areas to their natural state .

Storm-Water Management

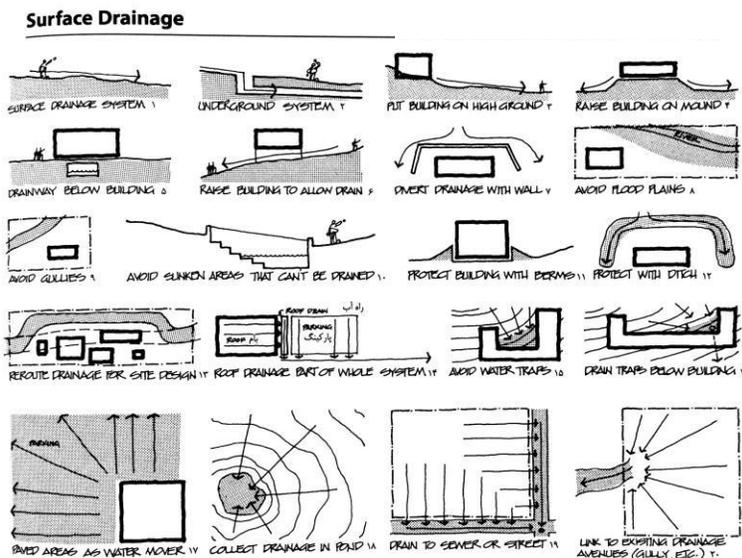
This credit emphasizes water consumption management with a maximum of 2 points. Its intent is to limit disruption and pollution of natural water flows by managing storm-water runoff .

- Rate and Quantity

In this case, increasing pervious surfaces can maintain natural flows and minimize storm-water rate .

- Treatment

Site storm-water treatment systems should be constructed to eliminate contaminants of storm-water. Mechanical or natural treatment systems such as constructed wetlands, vegetated filter strips and bioswales should be designed to treat the site's storm-water .



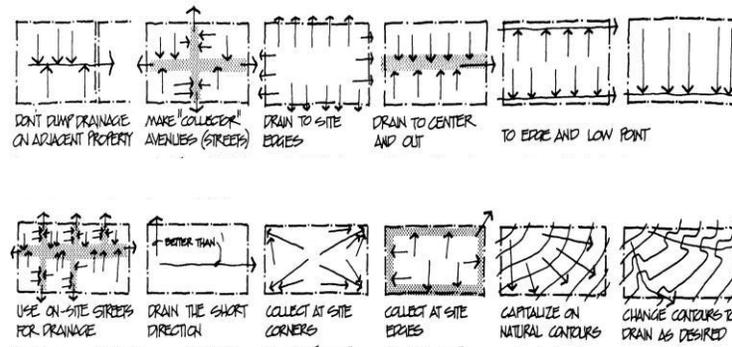


Figure 3: some kinds of surface drainages [8]

Heat Island Effect

It aims to reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize the impact on microclimate, human and wildlife habitat. In the LEED system, it has 2 points; yet, regarding the climate in Iran and especially its effects on people's comfort, the item should be highly regarded .

The effects of climate factor on comfort conditions :

A: Sunlight

- Biological and thermal effects on human
- Biological effect: UV rays sunburn white skin .
- Thermal effect: visible and infrared rays heat human body .

B: Humidity

- Increased humidity is associated with decreasing temperature of the dry weather. To decrease the temperature with increased humidity, vegetated areas, pools, fountains, or mechanical tools could be applied .

C: Wind (air flow)

- Wind and air flow can cool down body temperature through moving the air and increasing sweating .[9]

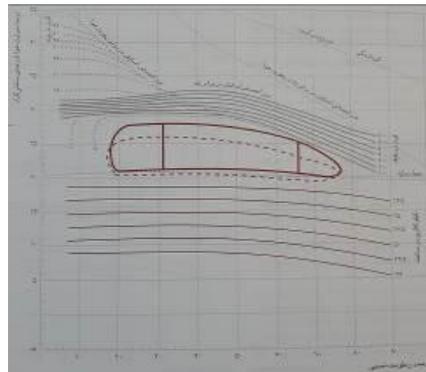


Figure 4: Eco-climate [5]

Since sunlight is the cause of natural light and thermal, it is considered as the main climate factor. Regarding the climate of southern Iran, the effect of this factor is increasingly observed on human and wildlife habitat. Thus, attention to heat island effect should be much higher than that in the LEED designer countries .

Sunlight affects a building with five types of ray :

- Direct low-frequency ray
- Low-frequency ray scattered in the sky
- Low-frequency ray reflected from perimeter surfaces
- High-frequency ray reflected from perimeter surfaces (thermal efficiency)
- High-frequency ray reflected from the building to sky (thermal efficiency) [9]
- Non-Roof Environments

Shade should be provided and/or light-colored/high-albedo materials and/or open grid pavement should be used for at least 30% of the site's non-roof impervious surfaces, including parking lots, walkways, plazas, etc., or a minimum of 50% of parking spaces should be placed underground or covered by structured parking. Due to high sunlight, this is highly important that approximately all parking lots in central and southern Iran should be placed underground or covered by structured parking. In this case, constructed surfaces on the site with landscape features should be shaded and the overall building footprint should be minimized. Constructed surfaces (i.e., roof, roads, sidewalks, etc.) should be replaced with vegetated surfaces such as garden roofs and open grid paving or high-albedo materials should be specified to reduce the heat absorption. In addition to create a sense of security, trees highly influence the physical environment and their perimeter. Additionally, planting deciduous trees on the southern front of buildings can both provide shade to control the daylight in the summer and provide the building with light and heat in the winter when it loses leaves.

- **Roof Environments**

Installing high-albedo and vegetated roofs to reduce heat absorption should be considered. In addition, a "green" (vegetated) roof could control thermal energy.

Light Pollution Reduction

The credit has 1 point and its intent is to eliminate light trespass from the building and site, improve night sky access and reduce development impact on nocturnal environments.

Conclusion

Considering the above-mentioned issues, it could be concluded that some of the items listed in the LEED green building rating system cannot meet the needs of all regions in Iran, due to climate and cultural differences of Iran and countries that designed the LEED, i.e. Canada, the USA, European countries and other more or less similar countries. Given the facts such as the extreme use of personal cars by the people in the tropical regions of Iran, lack of parking lots, the cultural issue of parking in the streets, the intensity of sunlight exposure in southern Iran, and consequently construction differences regarding the development density, it could be concluded that "alternative transportation" and "heat island effect" are far more important than "development density". Even, higher points could be considered for these items or different items could be added to the list. In the case of development density, due to the results raised here, lower points or different items could be considered to be included for rating the item. In addition, applying the LEED system significantly helps the economy, culture and environment of any country who applies this rating system. This can lead to economic growth and stable development of central and southern Iran in specific and the Islamic Republic of Iran in general.

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