Green Building visions in Arab historical cities, case study of Al-Jazirah Al-Hamrah, northern United Arab Emirates

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Abstract

With the oil discovery during 1960s and the initiation of the United Arab Emirates (UAE) in 1971, most of the old houses and buildings had been replaced with modern buildings. Al-Jazirah Al-Hamrah in the Northern UAE, the only historical UAE city maintained its original plan, since its existence in the seventeenth century. Looking at the city plan one can find that it has not been planned randomly. However, there are several critical issues have been taking into the account from environmental perspective, applying in present day “Green Buildings” as follow:

1. Most buildings –especially- houses are facing north or east to not encounter with the sunlight directly during the day time. This is not only for temperature control during summer and winter, but is applying on energy saving, and health standard.
2. The house rooms have extended shade roofs at their front. These roofs are covering the room’s windows which are parallel to the room’s doors. The windows are quite large (2 X2.5m). These windows entering the light during the early hours of the day, and cool air to the room during the summer.
3. There are louvers in the back of the rooms at very high elevation close to the ceiling. These louvers are allowing daylight during the mid day and afternoon without increasing heat.
4. The main gate of the house is normally facing east, this could be related to the shade availability. In the morning when the sun directly hits the gate, the temperature is cooler, or during the summer visitors can wait in the shade of the opposite neighbor wall.
5. There was a passageway between the houses from at least two sides of the house; this was to allow the fresh air recycling the house yard.
6. The size of the passageway between the houses creates shades for the pedestrians.
7. The town is built on coastal sand dunes in higher elevations to prevent the town from the sea flood, during abrupt storms.

Key words: Al-Jazirah Al-Hamrah, environmental perspective, green buildings, historical cities, United Arab Emirates.

1. Introduction

Green building, which is also known as a sustainable building, is the function of innovate structures using processes that are environmentally reliable and resource-efficient throughout a building's life-cycle. This practice is a complement to the classical building design with concerns of economy, utility, durability, and comfort. The goals of these type of building are to sustain the enviroment in all of their aspects, which includes; the building features (siting, design), construction (energy, water, materials), operation (waste, air pollution, water pollution, indoor pollution, heat islands, noise), maintenance (harm to human health, loss of resources), renovation, and deconstruction (environment degradation) (U.S. Environmental Protection Agency, 2009).

The trend of this type of architecure in the Western Countries is directly related to enviromental movements during the 1960s, and energy crisis during the 1970s. Rachel Carson's book Silent Spring in 1962 was influential not only on modern environmental movement but on public awareness of the enviromental issues concern (Bell and Walker, 2005; Grace, 2005 ). The critical of thermal performance of buildings on the climate has been arises from the 1960s, criticize what has been described as “glass box” architecture later during the 1970s (Hassall, 1973; Heathcote, 2007; Smith, 2001). The energy crisis of the 1970s in the United States which is retaliating for Western support of Israel in the October 1973 Mideast War. This is has resulted the Arab members of the Organization of Petroleum Exporting Countries (OPEC) temporarily barred oil sales to the United State and dramatically raised prices for all customers. In six months the price of a barrel of crude oil swells from three to eighteen dollars (Boyer, 2001). This has spurred significant research and activity to improve energy efficiency and find renewable energy sources. The formation of these two scenarios substantially was resulted the modern Green Building “movement” in the Western Countries, and USA in particular.

Ultimately, the concept of Green Building was essential in housing and town planning in Arab historical cities. This is simply because the environment was in charge, and the man was following its rules. However, from late 1960s with the oil discovery in United Arab Emirates, and the initiation of the State of United Arab Emirates in
1971, unsustainable planning and building have been developed, that accentuate the man power and diminish the nature power. Alternatively, most of old houses and buildings has been replaced with modern designs. Relicts of Al-Jazirah Al-Hamrah town in the Northern UAE, the only historical UAE city maintains its original plan, since its existence in the seventeen century. This study aims to highlight the vision of Green Building in the historical Arab Cities, taking Al-Jazirah Al-Hamrah as a case study. Emphasizing on the city plan and buildings incorporate with sustainable materials in their construction, healthy indoor environments with minimal pollutants, high lighting, and feature landscaping that reduces water usage.

2. Study area
The study area is located along the northern coastal plain of the UAE, southern Ras Al-Khaimah (RAK) (Fig. 1.a). Al Jazirah Al Hamrah means Al Hamrah (the red) Island. This name is indicating the main island in the area, which has been connected to the main land and become part of coastal plain (Fig. 1.b). Al Jazirah Al Hamrah has arid climate as most of the UAE. The average temperature ranges between 35-50 °C in the summer and 15-27 °C in the winter. The average rainfall is 130 mm occur mainly in the winter. The mean tidal range is 1.7 and 1.9 m (Goudie, et al, 2000). The Shimal (North) wind is not responsible for wave activity only in the northern UAE, but it is responsible for longshore currents which are the cause of the straight shoreline (Al-Farraj, 2005). The longshore current is the major factor in building the spit system in the northern side of the island. This spit system is plying a major role in creating harbors, and in return is the major reason for the town to develop on the island. This is together with ground water available.

3. Methodology
The area has been investigated from Google Earth images, and field observations. The building setting/orientation and designed has been developed from the Google images. The field observation was to document the goals of green building in the town underinvestigation by taking into account the material used for the construction and ventilation design, plus the building operation.

4. Results
The results have been classified to meet with green building goals including features, construction, operation, maintenance, renovation, and deconstruction.

4.1 The Building Features
This part is looking at Al Jazirah Al Hamrah town siting concedering environmental planing, and builing features which include building layout and design.

4.1.1 Environmental planning (Siting)
Environmental planning has been defined as a field of planning concerned with a given society's collective stewardship over its resources that ultimately includes those of the entire planet. Principal concerns of environmental planning is expressed in the assessment of three spheres; environmental impact, human economics activity and technological output (Selman, 2000). The town plan investigating of A Jazirah Al Hamrah shows that these three issues had been considered during the town planning.
The town built on coastal sand dunes in higher elevations to prevent the town from the sea flood, during abrupt storms. Present investigations show that the northern coast of UAE is subjected to sea flood in regular basis (Goudie et al., 2000). The siting of the town on the island was to maintain the natural resources (fishing and groundwater). The town developed from the northwest to south and later to the east express natural resource influence. The town center on the northwest is actually where the natural harbor is occurring. Thus, the homes are in walking distance from the working area (from their fishing boats) (Fig.2).
In the town planning the sunlighting is the key issue not only in understanding the shadow patterns of the house, but to assess their impact on the sunlighting of areas surrounding the buildings too. This is obvious as the town development is following the factors affect of the day lights. Although the distance between the buildings is very small (3-5m) this is not affecting the opening areas as the house scattered in groups (Fig. 2). The buildings are mainly one-story, with occasional two-story houses (Fig. 3), so there is no shading affect from the facing building. Between the houses there are no streets; it is only passageways, which developed later to streets. This tight size of the passageway is allowing the shade to form from the houses or their fences, and strengthen the wind speed. The shades in passageway are important to develop cool areas for the pedestrians, as there were no carriages at the time when the town built. Furthermore, all these passageway (urban canyons) are oriented north-south in order to achieve the best shading conditions in summer and the best lighting conditions in winter (Fig.2).

4.1.2 The building layout and design
The building layouts at Al Jazirah Al Hamrah vary according to each building’s duty. The mosques for example have to face southwest to the direction of Mekka (Kaaba). The shops alongside the harb
Figure 1: (a) Location and physical sitting of Al Jazirah Al Hamrah. (b) Planning development around Al Jazirah Al Hamrah from 1981 to the present.

Figure 2: Town plan of Al Jazirah Al Hamrah, notice the alignment of the passageway which is orientated North-South in order to achieve the best shading conditions in the summer and best light conditions in the winter.

Figure 4: (a) Mosque, notice the windows in all sides of the building. (b) Shops facing south, shade at the front made of palm trees leaf.
are facing south-southeast (Fig.2). This was not an
optional orientation, as these shops have to
frontispiece the community houses, which are their
clients. Facing south means facing the sun
throughout the day; to overcome this problem the
shops have shades at their entrances to cool them
down. In addition, shaded area in public was part
of social activity too, the it was a place for men to
meet and chat (Fig.4.).
The houses design rather different. They are either
facing East or North (Fig.5) to be encounter with
sun rays during the mid-day and the afternoons,
when the sun temperature at its peak. The houses
are facing east in order to provide good
transmission of light into the interior. As the town
is located in hot environment the daylight is
adequate even for those houses facing north. In
general, the climatic, geographical conditions are
specific to each site (Fontoymont et, al., 2004).

The windows too in Al Jazirah Al-Hamrah
buildings facing north or south determine the
optimum configurations, as: north facing windows
are: fairly low and constant illumination, minimal
heat gains, and large thermal loss during winter.
This is perfect condition for hot environment as in
the UAE. East facing house\window has medium
luminous levels, high energy gain in summer, and
low in winter, and has high illumination in the
morning (Mardaljevic, 1995). Adding into the
account that these windows are usually built under
extended shade roofs parallel to the room’s doors
for the aid of light and ventilation only, heating
theory does not exist in such arid hot environment.
These windows are quit large (2 X2.5 m). They
allow light to enter the room during the early hours
of the day and shaded cool air to the room during
the summer, when the air conditioning was not
invented yet. The Majlis (Men guest room) always
has its windows outside the house on the back wall
of the room (Fig.8). This is for the privacy of the
women in the house.
The house bedrooms and bathroom have extended
shade roofs at their front called Liwaa (Fig.6).
This wrap-around porch on the south, or east sides
of the house (depend on the house orientation) will
block the sun from heating up the house. These
extended roofs create large outdoor living spaces
underneath, which are ideal for warm living, since
people then were spending a lot of their time
outside anyway. This covered outdoor space is
large enough to hold portable beds or mattress to
sleep outdoor during the summer.
The bedrooms and bathrooms are often in one
alignment of the house. Kitchen and toilets are
relatively far from the bedrooms. The kitchen
usually has an out side extension for an oven built
within the ground. To operate this oven-like
feature coals or woods are used. For this reason
this extension usually has roof/shade only, but no
walls. This oven is used to grill the fish in
particular, and to cook food types that need low
continuous temperatures.

The piece of land around the house is usually
bordered by a fence making a wide front yard. The
need of the fence is for privacy reasons more than
security. This is because the Arab-Muslim culture
is very conservative, especially when it comes to
women. At the east side of the yard fence the main
gate is located. The gate is usually very large
(wide and high). If the home is owned by rich or
top in the society owners guest room (Majless) is
built near the main gate (Fig.6, 7, and 8). The main
gate of the house is normally facing east this is
again a shade related issue. In the morning when
the sun directly hits the gate, the cool temperature will not affect the guest who is knocking the gate, and during the afternoon there will be a shade from the house wall. However, during the summer the temperature is too hot even in the mooring (between 8-11:30 am). In this case visitors can wait at the neighbor wall shade until the gate is opened to them. This is will not offend the neighbor as his guests will wait at his other neighbor wall shade. In addition, the guest has to stay away from the gate, just in case one of the females in the house will open the gate. In Arab-Muslim culture it is not polite to look in the eyes or the face of your friend women (wife, daughters, sister ...ext). This solidarity and symbiosis were the main characters of the UAE society.

4.2 Construction

Construction usually involves energy, water and materials. Each of these topics will be discussed individually. These resources will be needed for the house operation as well as the house constructions. The buildings in Al Jazirah Al Hamrah town are energy, water and material dependent, in a way similar to autonomous buildings. These buildings custom-built to suit the climate and location, maintaining a passive solar techniques, alternative toilet and sewage systems and efficient windowing. However, people there and then were not making sacrifices in their lifestyle choices, because this is was the lifestyle then. Thus, it is in a way different than living in an autonomous buildings as it is described in Vale and Vale, 2000.

4.2.1 Energy

Al Jazirah Al Hamrah homes were energy efficient, because only a very small amount of energy was needed to operate in each house. This is because the room numbers in each house were few (2-4), plus the energy was needed for night lighting only, as all cleaning and washing were done manually. There were no need for air conditioning not only because it was not yet invented, but because these building are passive solar as they maintain their interior thermal comfort throughout the sun’s daily and annual cycles, as they face north or east, plus the nature of the material these houses were built of (Figs.2,5,8, and 9). This is together with low-density housing with relatively narrow passageways. This resulted in good ventilation within the homes, and maybe reflects a large part of the radiation away from the passageway, which will cool the walls temperatures because the rooms are part usually of the home fence (Figs. 5and 8).

Because these buildings are built to respond to sunshine, they tend to be designed differently paying specific attention to climate including: seasonal and daily hemicycle, and the traveling pattern of the sun’s rays. Therefore, size and orientation of the windows are very critical. In architecture, a window is one of the most essential constitutive in a building. It is required for light, views and ventilation. Variations in type, size, shape, location and orientation offer two designs in Al Jazirah Al Hamrah town; large windows (>2 m), and small louver/machicolation (<0.5 m) in the back of the rooms (Fig.8). Because of the fact that the windows are the greatest source of heat gain during the day, the large windows are shaded to reduce the amount of heated air and light rays entering the rooms. The louvers are at very high elevation close to the ceiling, designed to follow the traveling pattern of the sun’s rays, and allowing daylight during the midday and afternoon without increasing the heat. Each window design has different type of glazing. The large windows have patterned glass surfaces with several textures and colors, which control strength and visibility these are used for privacy reasons and decorative purposes. The louvers glass is usually patterned white glass to allow white light to enter.

4.2.2 Water

Enviromental planning is concerned about the disadvantages of transportation networks. Therefor, their designs tend to include more autonomous elements. This is not only to increase resource security, but to reduce the environmental impacts by using on-site resources which are in Al Jazeerah Al Hamrah case including water and fishing. Water resource in the town was coming
from two sources; groundwater and rain. The groundwater was the essential source, because every house has its own well. During the rain season (winter), they collect the rainwater in cisterns. The houses are constructed to include a system to channel the rain water that falls on the roofs through a series of gutters, and then it is moved manually to a large cistern. The water that is collected during the rainy season is enough to provide the drinking water needed throughout the year. The water in the cistern is usually not purified, thus kidney problem among the people was common.

### 4.2.3 Materials

A large part of green building goals is using local natural materials to minimize the negative effects on built environment and increasing the efficiency and adaptability of the structures. The natural materials known also as alternative natural materials. This type of building construction has existed for quite some time, but often in very basic forms nearly everywhere around the globe. The applications of alternative natural materials have made their way into more common use very recently in response to global warming and climatic change issues.

The original buildings in Al Jazirah Al Hamra have been built from the local natural materials; coral reefs from the sea and clay from nearby lagoon. The coral reefs has been used as bricks. The clay mixed with sand from nearby sand dune fields is used to cement the bricks. Later it used to plaster the walls, this is not only to give the walls better look. However, the mixture of the sand and the clay is ideal for the hot environments where Al Jazirah Al Hamra located. This mixture is exceptionally strong and heat-resistant, so it doesn’t let much heat through to the inside of the structure. Thus, it provides excellent insulation during the summer to reduce the room’s temperature and lower the energy costs.

### 4.3 Operation

In operating a house several environmental issues should be considered, such as; waste, air pollution, water pollution, indoor pollution, heat islands, and noise. In Al Jazirah Al Hamra most of these issues are irrelevant.

#### 4.3.1 Waste

Because the society in Al Jazirah Al Hamra lives on the minimum needs the waste was very minimum too. In addition, they used the waste of the cooked food, fruit and veggies as a food for their domestic animals (chickens or and goats or and sheep or and cows). The uncooked fish waste is used for the fertilizer of their desert trees (e.g Palm tree). Some of the cans and jars are reused. Thus, town has a very small waste dump.

#### 4.3.2 Air pollution

Buildings in Al Jazirah Al Hamra have no air pollution productions except from their ground-oven, which is built far away from the rooms, and these are not big fires anyway.

#### 4.3.3 Water pollution

There was no water pollution too in Al Jazirah Al Hamra as the sewage never reaches the groundwater level or the sea. In addition the groundwater never depleted as what is used throughout the year is recharged during the rain season.

#### 4.3.4 Indoor pollution

Indoor environment in Al Jazirah Al Hamra buildings was pollution free, as the rooms have very good ventilation and significant lighting quality. It could have indoor pollution from the ground-oven area, but this was located in an open area.

#### 4.3.5 Heat islands

Maybe there were heat islands developed from the sunlight hitting unshaded ground in Al Jazirah Al Hamra house yards. Otherwise, there were no heat islands related to house energy.

#### 4.3.5 Noise pollution

There was no noise pollution from Al Jazirah Al Hamra houses, the building material absorbs the noise, and the house yard ground is not covered with solid material that will reflect any voice or sound. Trees in the yard help to do the same job. Furthermore, there are no mechanical machines that would produce noise.

#### 4.4 Maintenance

As the buildings in Al Jazirah Al Hamra are very basic the maintenance is very basic too. It is basically on the painting the indoor walls with white cement. This is happened at least once every two years. Thus, the indoor environmental quality of these buildings used to have very high standards provide comfort, well-being, and productivity of
occupants. This is accommodated by the well developed construction produced high quality indoor air, thermal control, and significant lighting quality. As it is already known that daylight is playing an important role in implement quality of life and comfort in buildings. There are ample evidence that access to windows affect mood motivation and productivity and reduced fatigue and stress (Tabet, and Shelley, 1993). Thus, there were no crimes in the Al Jazirah Al Hamrah town.

4.5 Renovation & deconstruction
Although renovation and deconstruction are different concepts of building life-cycle, they will be dealt together in this investigation, because of their basic environmental considerations. Al Jazirah Al Hamrah town buildings are easy to renovate and deconstruct as a result of their basic construction style. Even if the building were deconstructed, they would not be harm the environment, as they have natural material. This town never depleted its resources and caused environmental degradation until recent constructions that are occurring around the area at the present time (Fig.1.b).

5. Conclusion
Although the green building trend is relatively new concept in the present time Al Jazirah Al Hamrah town had accomplished every goal of the green building since the seventeenth century. This is simply because the Man was obeying the Nature roles during that time, and because he was attached to her, which had made work with her rather than against her. He overcome her rigid harmful side (hot arid environment in case of al Jazirah Al Hamrah) using the optimum of his knowledge of her kind and useful side.

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