Demystifying Cultural and Ecotourism in the Vernacular Architecture of Siwa Oasis, Egypt

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Abstract

In the description of man's environment, the concept of habitat and shelter was the main motivation for buildings and hence the creation of a built environment. Building with the available materials and tools was the strategy being used then, however, human habitation and cultivation on this natural landscape has produced what is called "vernacular architecture". This kind of architecture is accordingly affected by the culture, traditions and habits of the local people, and has evolved over time in correspondence to the behaviour and changes made in the surrounding environment.

Siwa oasis is a place of pure natural beauty and with a unique architecture style. The architecture and the construction of the oasis were developed by the occupants of the oasis using local raw materials. The research presented in this paper aims to understand and clarify the culture and local life of the Siwan People, and search for the mechanisms that bridge the gap between heritage, technology and society, the material and spiritual. This clarification is vital to communities in the process of the rejuvenation of their built environment. Sustainable design and development should not be used as a tool to disenfranchise and control communities into neat tidy plots, but should render building as an activity for the rejuvenation and empowerment of communities. The role of the architect and his responsibility should be to understand and interpret culture, and change society through a proper understanding of their identity and needs.

In this paper an analytical review of the hot arid region of Siwa vernacular architecture is to be discussed and the influences affecting its significance are highlighted. This is followed by a discussion of the potentials of Siwa Oasis as a ripe land for cultural and ecotourism.

Ecotourism can bring numerous economic benefits to Egypt. It generates foreign exchange, creates local employment, stimulates national and local economies, and increases environmental awareness and education, while preserving the resources tourists come to experience and enjoy. This paper proposes a new building technique using new raw materials available in the oasis in order to enhance the performance of the buildings as part of a set of sustainable strategies for development. The paper puts forward a critical review of sustainable design strategies to enhance cultural ecotourism in the Siwa Oasis. Climatic design of buildings using passive design techniques is recommended to provide comfort to the occupants and at the same time promote and revive the natural beauty and architecture of Siwa oasis. The paper concludes that sustainable construction, using the available local assets and best utilizing them without harming the surrounding environment and public participation is the best approach for promoting ecotourism in Siwa Oasis.

Keywords: Vernacular Architecture; Climatic Design; Ecotourism; Sustainable Design.

1- Introduction

In recent years, a new type of nature-based tourism has been gaining momentum. More tourists are seeking a new kind of tourism that provides them with the opportunity to escape the hustle and bustle of the modern world and enjoy the beauty and serenity of nature. This type of tourism called "ecotourism." According to the World Tourism Organization (WTO, 1996), ecotourism has been estimated to account between 10% to 15% of all international travel expenditures. It is quite clear from the above trend that unless this growth receives careful and professional guidance and planning in Egypt the outcome will not be able to compete with the international precedence (Elnokaly, 2013).

Today, the tourism sector could not remain dismissive and unresponsive to the global sustainability challenge of our times. Accordingly, the World Tourism Organization (WTO) supports national and local governments, as well as the tourism industry in their decision making process and day-to-day operations, by focusing its advisory and technical assistance services on policies, development guidelines, management techniques and measurement instruments to incorporate sustainability principles (UNEP, 2005). Tourism is the largest source of foreign exchange earnings for Egypt, contributing almost 12 per cent of GDP including indirect effects, such as generating large numbers of jobs (UNEP, 2005). Tourism industry in Egypt has traditionally focused on cultural tourism, it is believed that ecotourism can bring numerous socio-economic benefits to Egypt, accordingly, well-planned and ecologically sensitive facilities or Eco-lodges in key potential ecotourism areas are now a necessity.

Siwa is one of the few Egyptian oasis communities that have managed to retain most of its traditional characteristics. As the people of Siwa confronted the modern world, both their culture and their environment were exposed to the risk of disruption. The Oasis is one of the areas rich with distinguished tourists attractions including monuments tourism, therapeutic tourism, safari tourism and desert tourism. Siwa oasis as a case study of this research present an environmentally significant area. An environmental approach is adopted in order to develop Siwa environmentally, and hence it will eventually play an important role in enriching ecotourism in Egypt.

The main objectives of this research are to suggest an architectural building design technique to improve the comfort, introducing the most relevant architectural design method of building according to the surrounding climatic elements , Investigating the problems resulting from the traditional construction technique in Siwa Oasis using local raw building materials and performing an experimental program in order to find other raw materials that could be used in the experimental program in order to enhance the construction process in Siwa Oasis.

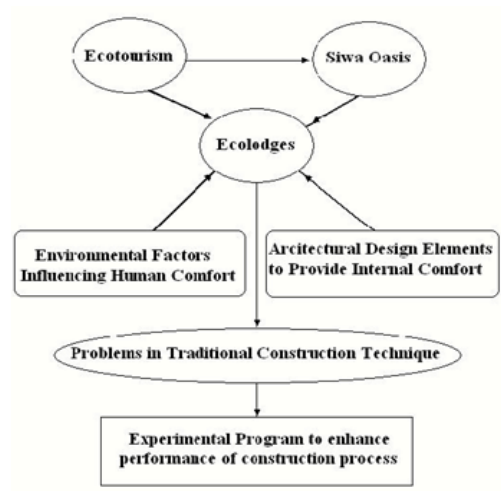

Figure (1): Flowchart representing the interconnection between various factors influencing the design of Eco-lodges

The main objectives of this research shown in Figure (1) are to suggest an architectural building design requirements to improve the comfort, introducing the specific architectural design elements of building according to the surrounding climatic elements , Investigating the problems resulting from the traditional construction technique in Siwa Oasis using local raw building materials and performing an experimental program in order to find other raw materials that could be used in the experimental program in order to enhance the construction process in Siwa Oasis.

2- Concept of Ecotourism

Today ecotourism is one of the most popular contending conservation and development strategies. In addition, to restraining the often-detrimental effects of large-scale, conventional tourism on local communities and ecosystems, ecotourism holds the promise of overcoming a number of today's biggest environmental and social challenges. In principle, ecotourism can help conserve biological and cultural diversity, alleviate rural poverty, strengthen ties between nature and built environment, increase public awareness of environmental concerns, and manifest a new 'triple bottom line' for business that includes profit, social benefits and environmental conservation (Stronza, 2008). Concomitantly, interest in ecotourism has never been greater. The World Tourism Organization (WTO, 1996b) states that ecotourism is now the fastest growing segment of an already mammoth tourism industry. Ecotourism in its purest form is an industry which claims to make a low impact on the environment and local culture, while helping to generate money, jobs and help the conservation of wildlife and vegetation. Ecotourism is claimed to be a responsible tourism which is ecologically and culturally sensitive (Panos, 1995; UNEP/IUCN/WTO (2002)).

2-1 Principles of Ecotourism

Ecotourism is the latest trend in travel industry; it protects the natural environments and at preserves the cultures of the inhabitants of those environments. Carla Hunt (1998) argues that the general concept of ecotourism arose with the realization of the potential benefits in combining people's interest in nature with their concern for the environment. However, ecotourism has another dimension since it is believed that it can become a perfect economic activity for local populations.

When thinking about applying ecotourism in any region certain criteria must be present in this region in order to be converted into an Eco-touristic place:

- Unspoiled natural environment.
- Region of historical monuments.
- Region of unique architectural style.
- Traditional way of life.
- Unique flora and fauna.

2-2 Problems Associated to Ecotourism in Developing Countries

Developing countries have the necessary natural resources upon which to base ecotourism projects, however if the future is to be truly sustainable, developers must recognize the associated problems of ecotourism.

Spearheading is seen as one of the largest problems for the development of ecotourism. Also as the numbers of Eco tourists entering fragile ecosystems increase above the permissible limit this may have a disruptive effect on the natural environment and damage local culture and heritage (TWHCS, 1999).

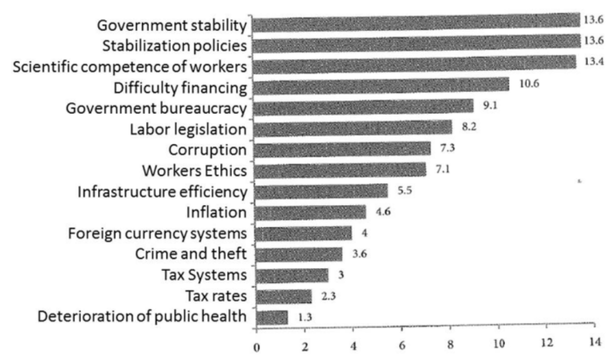

Figure (2): Relative ranking of the structural constraints faced by the movement of investment in Egypt "Total 100" (WEF 2012)

This has been the case in many so-called ecotourism destinations such as The Hol-Chan Marine Reserve in Belize, where increasing amounts of Eco-tourists are being blamed for environmental degradation (Cater, 1992).

Leakage of benefits: It is asserted that if Eco touristic projects are not researched and guidelines are not set out, then a large proportion of the economic benefits may in fact by-pass the needy local economies, accruing instead to tour operators in developed countries. The Annapurna region of Nepal, marketed as an ecotourism destination, is a good example of this problem. It is estimated that only 20 cents of the US$3 that the average eco-tourism spends daily actually benefits the local community (Pleumarom, 1994). This leakage of benefits has been a long recognized problem of tourism in developing nations (CBSD, 2002). The significance of this was estimated in 1988 when it was shown that 55% of gross tourism revenues in developing nations ended up in the pockets of wealthy foreign investors in the developed world (Ceballos, 1996).

In addition to the above problems, the case of Egypt, Siwa includes too many structural constraints (WEF, 2012) faced by the movement of investment. Figure (2)

2-3 Effect of Ecotourism on Economy

It is believed that ecotourism can bring numerous economic benefits. Ecotourism generates foreign exchange, creates local employment, stimulates national and local economies, and increases environmental awareness and education, while preserving the resources tourists come to experience and enjoy. There is excellent evidence that ecotourism can help to pay for the conservation of natural resources. Studies have been undertaken for over a decade now to demonstrate that countries can raise local economic benefits and use wilderness resources as a primary attraction for visitors without destroying the “goose that laid the golden egg." The key is to raise fees for international visitors, collect fees and use the fees for environmental protection (CBSD, 2002). The World Resources Institute reports that nature based tourism is growing at the rate of between 10 to 30 percent each year, while other types of tourism grows at a rate of 4 percent. Australia is a good example of nature-based tourism. Tourism is Australia’s largest export industry (Shea, Syd & Sharp, 1993). Between 1983 and 1993, the number of international visitors increased from 944,000 to 3,000,000, an average annual growth rate of 12% (Shea, Syd & Sharp, 1993). The tourism industry generated $10.6 billion in export earnings and employed 130,000 people in 1994 (TFC, 1995). Australia undertook a thorough survey of its nature-based tourists in 1995. Results confirm that national parks and reserves have "high appeal" among international visitors to Australia (Blamey and Hatch, 1998).

2-4 Ecological Design

Ecological design can be envisaged in terms of sustainable architecture philosophy that can be labeled as ecotecture for tourism facilities. Such philosophy is regarded as an approach that demands an understanding of the consequences of certain decisions and actions. Aspects of ecotecture development process can be understood when compared with the development process of conventional architecture in terms of goals, means, and resources as shown in Table (2).

As the industry of ecotourism expands, well planned and ecologically sensitive facilities are in high demand, in fact they have become a necessity, this demand can be met with ecolodges. Ecolodge is a tourism industry label used to identify a nature dependent facility that meets the principles of ecotourism. Such a facility is developed and managed in an environmentally sensitive manner in order to protect its operating environment (Hawkins, 1995) and relates back in time to the history and culture of a place (Kern, 2003). The most important thing when designing an ecolodge is the quality and the purity of the surrounding environment. Other critical concerns would include the nearby natural and cultural attractions, the way in which ecotourism is operated and marketed, and the way in which local people are involved in the process of developing and operating ecolodges (Ceballos, 1997). Ecolodges are constructed using recycled and locally produced building materials. It relies on solar or alternative energies, recycles the waste and the wastewater it generates, serves locally grown and produced food.

Table (1): Comparative analysis between the development processes of conventional architecture and Eco-tecture, (Hawkins, 1995)

Terms of Comparison	The development Process of Conventional Architecture	The development Process of Ecotecture
Goal	- Greed driven to make a large profit	- Community driven to meet community needs and social aspirations
Means	- Land speculation - Community exploitation	- Land nurturing - Community empowerment
Financial Resources	- Borrowing from anywhere mostly banks - Profits Exported	- Ethical investment - Profits benefit the community
Materials and Human Resources	- Anything goes / Convenient - Market driven - Capital intensive - Nature and people are treated as the fuel of economic activity	- Carefully selected - Environmentally responsible - Labor intensive - The economy is in the service of community and ecology

2-4-1 Ecolodge Design Process

The design process is intended to be a logical treatment and rigorous reasoning for solving environmental problems (Sanoff, 1977). The Ecolodge design process involves extensive research as a predesign phase (Graber, 1993). The purpose is to incorporate knowledge generated from research into design. The design process encompasses two major phases, each of which is a multi-step process.

The two phases are: the Research Phase and the Design Phase. The research phase includes the evaluation the surrounding landscape, developing the architectural program and defining design imperatives. Although every ecolodge design process would have a specific set of imperatives, a generic design decision making checklist can be envisioned:

- Use the simplest technology appropriate to the functional needs.
- Provide minimal environmental disruption.
- Optimize use and flexibility of spaces
- Minimize impacts on natural and cultural resources.
- Provide equal access to the full spectrum of people.

3- Ecotourism Concept and associated problems in Siwa Oasis

Egypt is rich with many beautiful and unique oases in the Western Desert. The most important are Fayoum, Kharga, Dakhla, Baris, Farafrah, Bahereya, Siwa and the Qattara Depression. The word ‘Oasis’ was originally an Egyptian word from the Coptic ouahe. Egypt's oases are still the most varied in the world, each with a special character of its own.

Siwa oasis is located about 65 Km east of the Libyan border and 300 Km south west of Marsa Matrouh. The oasis is 82 Km long and has a width which varies between 2 and 20 Km. This depression lies between longitudes (25° 12") and (26° 05") E and latitudes (29° 05") and (29° 20") N, and its centers at about (29° 13") N latitude and (25° 42") E longitude. Most of the central part of the depression lies below the sea level (Müller, 2012),. The Siwa Oasis is unique in many aspects. It has a magical natural beauty and a distinguishable architectural style. It was declared a protected area in the year 2002 and it is very important to guarantee the sustainable development of Siwa Oasis. Siwa deserves to be called the oasis of history. It was first mentioned more than 2,500 years ago in the records of the Pharaohs, during the twenty-sixth Dynasty (663-525 B.C.).

3-1 Main Sights in Siwa Oasis

Siwa is one of the most beautiful oases of Egypt. It is full of historic monuments and beautiful natural places to visit (Ghazal Safari, 2012);

- Aghurmi, Located 4 km from Siwa, probably housed the famous Greek oracle of Jupiter Amoun which dates to the 26th Dynasty;
- Gabal Al Mawta, The Mountain of the dead is a hill side full of tombs which were unknown to 19th century explorers;
- The fortification of Shali, located in the center of modern Siwa, and is basically the old town;
- Cleopatra Spring a stone pool fed by natural spring water, and probably the best known pool in the area;
- Dakrur Mountain, This is where people come to the area to be relieved of rheumatism complaints;
- Fatnas, Ain Qurayshat and Abu Shuruf Springs are better springs than the famous Cleopatra's spring;
- Zeitoun Village, lies east of Siwa and just next to another large, salt lake by the same name, The buildings are mostly mud-brick. There are hundreds of Roman period tombs in the area nearby.

Siwan people and environment face a number of problems that threaten the future sustainable development. Such problems are directly linked with human and technical resource constraints.

3-2 Key Guidelines for Future Development Initiatives in Siwa

Proposed below are a number of key guidelines and a critical review of current literature for future development initiatives in Siwa, covering the areas of cultural heritage preservation, socioeconomic development, infrastructure development, and biodiversity conservation.

- **Cultural Heritage Preservation**

Protection and Revival of Traditional Handicrafts: Traditional arts and crafts reflect the artistry and creativity of Siwan women. To avoid the extinction of these traditions, projects should be designed that targets household-based enterprises.

- **Socio-economic Development**

There seem to be many opportunities for the development of the existing small enterprises that feed the needs of the growing urban population:

- Expansion in Agricultural and Industrial Activity
- Development of Tourism
- Establishment of Education and Research Institutions
- Conservation and Management of Water and Wastewater
- Development of Solid Waste Management System
- Conservation of Biodiversity by Establishment of Desert Park

- **Rehabilitation and Preservation of Traditional Architecture patrimony**

Efforts need to be expended to rescue existing examples of traditional housing, and to repair damaged structures. This is not only because of the inherent value of these structures, but as a way to improve the quality of the life of the residents. Available options to save what remains of Siwa's unique architectural heritage need to be taken. The possibilities of technically refining traditional building methods and of using new technologies to adapt and improve traditional building materials need to be explored. A proposal of new building technique using new raw materials available in the oasis is discussed below in order to enhance the performance of the buildings.

- **Architectural building design requirements in Hot Climate, the case of Siwa**

In vernacular architecture, there is a strong relationship between site, climate and the elements of building in the generation of the building form. The inclusion of landscaping in the form determinant features is important as this can act as an additional climate modifier to the building. Design strategies can be split into two levels, the first relates to general building and environmental control characteristics such as materials, plan shape and section that can also be dependent on cultural and social values. The second relates to specific aspects of building form such as the plan orientation, landscaping, verandas and courtyards. Moreover, the main building elements are also related to climate types.

Orientation

The orientation of buildings would be determined partly by the sun and partly by the wind. The best orientation for the sun would be with the long axis of the building lying east-west, which is a common principle of architecture. But at the same time it is required that wind flows to the inside of the house using appropriate strategies of cross ventilation to cool it during the summer. If the prevailing wind is northwest, so the house should be oriented northeast to southwest perpendicular to the prevailing wind.

Facades

Northern Façade*:* This facade is least exposed to the sun. An advantage to rooms opening on this facade is that their illumination is always evenly distributed, making them ideally lit places with less overheat in summer.

Southern Façade*:* With regard to the sun factor, an advantage of southern exposure in the Tropics and Subtropics is that the sun is high over the horizon in summer and can be shaded using a relatively small overhang. In winter it is low, allowing the sunshine to penetrate when it is most desirable. However, with regard to the wind factor, a disadvantage of the southern exposure is that it receives no wind, since the cool prevailing winds generally blow from a northerly direction in the Northern Hemisphere. Although the rays of the sun cannot be manipulated and directed at will however, there still exists the usage of light shelves, there are ways of directing airflow to rooms with a southern exposure, either by appropriate layout of opening at different heights utilizing stack effect or by such devices as the malqaf, the wind escape, and even the indoor mashrabiya as seen in a lot of the traditional houses in Egypt and northern Africa cities.

Eastern & Western Facades: The eastern facade is exposed to the rays of the sun only from sunrise to noon. The walls cool down considerably by evening, making this exposure more suitable for bedrooms than the western exposure.

Facades Shading

Utmost care should be taken in ensuring that the openings in the envelope of the building are effectively shaded. In hot arid climates, solutions were developed to control the different function of openings as the venetian blind, and the mashrabiya that has five functions: controlling the passage of light, controlling the air flow, reducing the temperature of air, increasing the humidity of the air, and ensuring privacy (Elnokaly and Elseragy, 2013).

Wind Effect

The architectural design can ensure such natural air movement through two principles. First, differences in wind velocity produce a differential pressure which results in air flowing from the higher to the lower air pressure region. In the second, warm air is less dense than cool air and therefore will rise in an environment of cool air. Thus the use of such strategies can enhance the stack effect, all of which are utilized in the following architectural vocabularies.

Claustrum: Mainly used to evacuate the hot air collected in the higher parts of the room, or in parapet walls, (low walls around roof edges), to produce drafts over people sleeping on the roofs in summer.

Wind escape: This concept can be applied more advantageously in designs for use above the ground. The wind-escape can accelerate effective ventilation and air circulation when used with other devices for air movement such as windows, doors, and the malqaf or wind-catch.

Malkaf: This device is a shaft rising high above the building with an opening facing the prevailing wind. It traps the wind from high above the building where it is cooler and stronger, and channels it down into the interior of the building.

Badgir: A specific type of malqaf called the badgir was developed. It has a shaft with the top opening on four sides, and with two partitions placed diagonally across each other down the length of the shaft to catch breezes from any direction.

Sun Effect on Air Movement

Architectural elements can be used to take advantage of the sun factor as a driving force for maintaining air movement. This technique is applied where large areas are available and is based on the principle of convection. Courtyard and takhtabush are examples of these architectural elements.

Courtyard: In hot zones people learned to close their houses to the outside and open them inwardly onto internal courtyards called sahn, which are open to the sky. This arrangement provides drops in air temperature of 10-20°C at night. As evening advances, the warm air of the courtyard rises and is gradually replaced by the already cooled night air from above. This cool air accumulates in the courtyard in laminar layers and seeps into the surrounding rooms, cooling them. In the morning, the air of the courtyard, which is shaded by its four walls, and the surrounding rooms heat slowly and remain cool until late in the day when the sun shines directly into the courtyard.

Takhtabush: A type of loggia, a covered outdoor sitting area at ground level, located between the courtyard and the back garden, opening completely onto the courtyard and through a mashrabiya onto the back garden. Since the back garden is larger and thus less shaded than the courtyard, air heats up more readily there than in the courtyard. The heated air rising in the back garden draws cool air from the courtyard through the takhtabush, creating a cool draft.

The humidity factor

Water is scarce in desert lands, and people in the hot arid zones have always cherished water and tried to remain in contact with it as long as possible. Apart from its refreshing effect physically, water is very important in increasing the humidity and thereby promoting thermal comfort in hot arid lands. Thus, the fountain and salsabil is an architectural feature occupying a privileged place in the house.

The fountain: the fountain occupies a place in the center, displaying its water and mixing it with air to increase humidity.

The salsabil: In places where there was not enough pressure to permit the water to spout out of the fountain head, architects frequently replaced the fountain with the salsabil which is a marble plate, decorated with wavy patterns suggestive of water and wind, which is placed against the wall inside a niche on the opposite side of the a sitting space.

Heat Transfer through Building Elements

As a consequences of the high diurnal difference in hot arid zones, the comfort of people inside buildings in this district depends largely upon the thermal properties of the walls and roof.

Roof: The reflectivity of the outer surface of the roof and the thermal resistivity of its materials are of primary importance (Elseragy and Elnokaly, 2007). A useful idea is to shade the roof more naturally by designing it to suit popular traditions. In hot arid countries, since air temperature drops considerably during the night, the inhabitants have arranged the roof architecturally into loggias or open galleries and lightweight roof covers. These loggias and roof covers have the double function of shading the roof during the day and providing physiologically and thermally comfortable living and sleeping spaces at night. The shape of the roof is very important in a sunny climate. First, the increased height, provide a space far above the heads of the inhabitants for warm air that rises or is transmitted through the roof. Second, for most of the day, part of the roof is shaded, These effects are particularly effective for roofs vaulted in the form of a half cylinder and those domed in the form of a hemisphere (Elseragy and Elnokaly, 2007). Domed and vaulted roofs also increase the speed of any air flowing over their curved surfaces due to the Bernoulli Effect, rendering cooling winds more effective at reducing the temperature of such roofs.

External wall: The design of external walls is of vital importance as they play a major role in shielding the building from heat transmittance during summer and heat loss during winter. Facades receiving sun heat and light during summer should be insulated properly or the building materials used should be highly thermal resistant, double glazing for the windows or any mean of shading devices should be used. Hence the design of the building fabric should follow the strategy of 'Build tight, ventilate right'.

Wall and roof color: The color of the external envelope of a building determines the impact of solar radiation on the building. Three physical properties determine the radiant exchange of a surface with its environment: the absorptivity, (a), reflectivity, (r), and emissivity, (e) of the surface. Solar absorptivity and reflectivity are related by the formula: $r = 1 - a$ or $a = 1 - r$

Any surface emits and absorbs radiant energy in proportion to its emissivity, (e). This property is independent of the color and for almost all nonmetallic surfaces the emissivity is about 0.9, regardless of their solar absorptivity.

Building material: The heat transfer is proportional to the air temperature difference, area of the wall, and rate of global heat transmittance that can be determined from an analysis of the components of the total resistance to heat flow (Elseragy and Elnokaly, 2007. To reduce the heat transfer, the thermal transmittance must be reduced as much as possible by either increasing the thickness of the wall or using materials of lower thermal conductivity and therefore of higher resistance. In hot arid climates, the coefficient of thermal transmittance should be about 1.1 kcal/hr.m^2.°C for an external wall to have an appropriate thermal resistance. Sun-dried earth brick is one of the poorest conductors of heat due to its low natural conductivity, Mud is weak and necessitates thick walls. Experiments has proved that mud brick is most appropriate for achieving thermal comfort in addition to being widely available to all segments of the population.

4- Siwa construction at the present time

This stage started with the beginning of the twentieth century, when the Egyptian authorities stared on connecting with the oasis, Egyptian authorities started to build public buildings as Seedi Soliman mosque and the police station and schools. These reinforced concrete buildings were constructed without any special style. Institutes, hospitals and other governmental are built randomly and without any kind of supervision or planning from the government (Dabaieh, 2002). The new town of Siwa oasis is located below the ruins of the old town of Shali. The difference between the two styles is clear; the ruins of Shali suit the oasis and give it a unique and distinguish style, while the new construction does not follow the ecological oasis style and hence is a threat to the traditional construction style.

New residential area has been constructed in the south of the oasis. The new residential area consists of economic reinforced concrete houses that are built all over Egypt. By studying one of those economic units it was found out that it consists of two bed rooms, small reception, kitchen and a bathroom. It can be realized that it is different from the Siwan house but the Siwan people were impressed with the new concrete units that can fulfill their social needs and look more safe. The problem was that the units could not provide comfort for the inhabitants and did have negative impacts (Dabaieh, 2002). The new roads reduced the time of traveling and transport which contribute to the expansion of this inhuman construction.

4-1 Traditional Technique of Construction in Siwa Oasis

The local materials that are found in Siwa oasis are Karsheef, silt from the surrounding lakes (Silt L), silt from surrounding hills or mountains (Silt M) , Badya brought from the mountain known as "White Mountain" or "Adrere Amellal", and fine reeds which grow naturally on the sides of the salt lakes which is known as "Sommar" in Siwa oasis. Some other available materials in Siwa oasis are palm trees wood and olive trees wood. It should be noted that Karsheef is a stone made of a mixture of clay, salt and fine sand that forms at the shores of the salt lakes. Karsheef particles play the role of coarse aggregate in conventional concrete.

The method presented below has been mainly developed in Siwa oasis by experience. It should be pointed out herein that there is no evidence for performing any kind of tests to ensure the validity of the traditional construction technique in Siwa Oasis.

- **Bearing Walls**

Walls are built with Karsheef particles that are bonded together with a local mortar; Siwan mortar (SM). The step-by-step application method may be simply explained as follows:

- Karsheef particles are cut into smaller particles of length between 30 to 50 cm, width of 15 to 25 cm and thickness of 10 to 15 cm.• Siwan mortar is prepared to be used in bonding Karsheef particles. It is made of two types of silt "Silt L" and "Silt M". The mixing proportion is 4 Silt L:1 Silt M:1 and water.
- The two kinds of silt are mixed together then water is added slowly while mixing them with a shovel.
- Siwan mortar should always be kept wet. In another word, the mortar should be used as a bonding material before reaching its setting time. If the mixture will be left to be used for the second day, it should be sprayed with water.
- The ground is scratched before placing the first layer of Karsheef particles so they adheire strongly with the ground. This approach is typical to the same way of bonding old

concrete with new concrete, as the harden concrete should be well grinded and roughed with "Jack Hammers" to ensure that bond.

- Karsheef particles are arranged in the form of a line on the ground.
- Siwan mortar is pushed hardly in order to fill all the spaces between the Karsheef particles and to bond them strongly.
- Another layer of Karsheef is then arranged above the first one. Each Karsheef particle is also pushed by hand towards the underneath mortar, and then mortar is added again to bond the new Karsheef particles.
- The process is repeated till a height of 1.00 m is reached.
- The first 1.00 m is left to dry before completing the work and starting the construction of the additional height. In fact, the wall is typically left for two days during the summer and nearly two weeks during the winter to reach the complete drying condition. This is due to the wide variation in temperature and Relative Humidity between the two seasons.
- After the wall is completely dried the work is continued till the second meter is finished.

Finally, the work is repeated till the required height is achieved

- **Ground Level Floor**

Flooring of the ground level is made of stone particles cut into large pieces of square shape and they are placed on the ground, The stone particles get strongly attached to the ground due to their own weight. The flooring of the second floor is mainly made of palm trees wood.

- **Roof**

The roof of the intermediate floor consists of several layers starting with palm trees wood, olive trees wood, Karsheef, and silt. Palm trees wood before being used are cut into halves, sprayed with salty water and left in the sun to dry, Figure. This step is performed in order to provide adequate protection against white ants. Palm trees wood are then cut, shaped and then arranged perpendicularly on top of two parallels walls spaced at 4 to 5 meters, and span of 1 to 1.5 meters. The palm trees wood is then covered with wood from olive trees roped together like a mate. The final layer is made from palm trees wood placed above the olive trees wood.

The Roof of the last floor which is usually the second is constructed exactly as the roof of the intermediate floor, but instead of covering olive trees wood with palm trees wood for the final cover, Karsheef particles and silt are used to be placed above the olive trees wood, where they form the final layer then silt is used to cover the roof externally. It should be pointed out that the palm trees used are deteriorated trees.

4-2 Problems Associated with Traditional Construction Method

The following paragraphs present the main problems or constraints that evolve with the traditional construction techniques in Siwa Oasis.

Serviceability : Siwan houses cannot stand heavy rain. Although rain is rare in Siwa Oasis and if it occurs it is very light, but heavy rain do occur randomly. It has a bad effect on the external walls, as silt particles start falling and the bond between them and Karsheef become weakened. The problem may undergo beyond serviceability and may reach safety.

Settlement : The houses in the oasis built three or more years ago, are marked by vertical cracks. The width of these cracks increases with the aging of the house. The main reason for these cracks is settlement of foundation. Foundation in Siwa oasis is constructed using karsheef bonded with siwan morter (SM), where a hole of the same area of the house and of a depth of nearly 0.5 m is dug and karsheef boned with SM is layered into the hole where the final layer is filled with SM till it reaches the ground. Since the process is carried out manually the voids between karsheef particles is not completely filled with SM. When the houses are subjected to different loads for a long time, displacement of karsheef particles take place causing settlement of foundation, so vertical cracks start to occur and they increase and widen with time.

Collapse : The problem may exceed both serviceability and settlement and it may reach sudden collapse, as took place in Shali village, when Siwa oasis was subjected to heavy rain which completely destroyed half of the houses and the remaining were not safe enough to be used again.

4-3 Experimental Investigation

Materials used in the current work (Hussein, 2005) are two available types of silts in Siwa Oasis (Silt L and Silt M), the white material known as "Badya", the solid particles known as "Karsheef" and the ash resulting from the combustion of the reed known as "Sommar". Molasses were also used in some mixtures to act as a water-reducing admixture as an attempt to improve the workability. It should be pointed out that the use of Badya, Sommar ash and molasses as construction materials has not been experienced in Siwa Oasis up till now. The currently used materials in Siwa Oasis (Karsheef and both silts) and the introduced materials in this work (Badya, Ash and Molasses) are summarized in the flowchart given in Figure (2). In fact, the new materials introduced in this work are those acting as binders while Karsheef is the only material used as coarse aggregate.

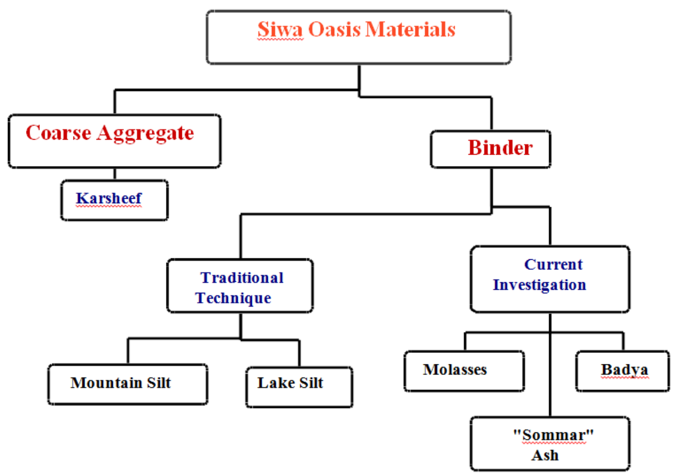

Figure (2): Flowchart representing the building materials in Siwa oasis

Proposed Mix Design

The mix design proposed herein is considered as "Modified Siwan Mortar". It can be produced considering the followings:

1- The proposed mortar consists of Silt L : Silt M : Badya : Ash following the ratios 4:1:1:1 by weight.

2- Molasses is incorporated by 3.5% of the total solid materials by weight.

3- The two silts and the Badya should be grinded and sieved on Sieve No. 30. The resulting powders are to be collected and used. Obviously, any comparable screen may be accepted in practice.

4- Again, the main key of producing good binder is the controlled burning process of the ash. Sudden cooling of ash is a must. The burnt ash is to be dried and then grinded on Sieve No.100 or other comparable screen.

5- No need for using heating process in an oven as followed in the experimental program. This process was adopted to simulate the actual climate condition in Siwan Oasis. The strength of the proposed mix may exceed 80 Kg/cm2 at the age of 56 days. It is of great interest to state that the Egyptian Standard Specification ESS 1292/1991 accepts bricks having strength exceeding 50 Kg/cm2 to be used as bearing walls in construction industry. Therefore, the proposed construction technique for the above mix follows the Egyptian specification standards.

Conclusions and Recommendations

Although, Egypt is a rich tourism destination, however, it can be seen that ecotourism is still in its infancy. One of the parameters to establish a successful Eco touristic region is providing comfortable Ecolodges. In order to set the guidelines concerning the development of comfortable ecolodges in Siwa Oasis, this paper has provided through a critical review an understanding of the following:

The human comfort standards; the introduction of the different architectural elements, and their role in providing internal comfort; the term ecotourism and its principles and how it can affect the economy; The parameters that must be found for a successful ecotouristic site.

The ecolodge concept and characteristics have been redefined within the Egyptian context, illustrating different attitudes about the natural environment and the enhancement by adding new raw materials available in the oasis, it can be concluded that:

1. Ecotourism in its purest form is an industry which claims to make a low impact on the environment and local culture, while helping to generate money, jobs and help wildlife conservation.

2. A true ecotourism and ecolodge culture has to be spread out amongst different sectors of Egyptian society so that local authorities, private sector, professionals and local communities are properly and actively involved, and are benefited from the process.

3. The traditional construction technique in Siwa oasis resulted into unique distinguishable architecture style of shelters but at the same time these shelters are not safe due to the weakness of the natural building materials used.

4. The compressive strength of the currently used mortar in Siwa Oasis is not promising (13.5 Kg/cm2) and may lead to very serious construction problems. This finding emphasizes the need of modifying the Siwan mortar by introducing other materials available in Siwa.

5. Preliminary tests indicated that an appropriate selection of local materials available in Siwa Oasis is of primary concern to improve the performance of the binder. The experimental process investigated and presented in this paper indicates that many readily available materials can be used in Siwa Oasis.

6. Materials used in the current work are two available types of silts in Siwa Oasis "Silt M" that is brought from the surrounding hills or mountains, "Silt L" that is brought from the surrounding lakes, the white material known as "Badya", and the ash resulting from the combustion of the reed known as "Sommar". Molasses were also used in some mixtures to improve the workability.

7. The combined effect of the addition of Badya and Ash on the strength of the Siwan Mortar may lead to very promising results. A compressive strength on the order of 57.2 Kg/cm2 at the

age of 56 days was achieved. Moreover, when molasses was incorporated to that mix the water content reduces from 20% to 15% and hence the mortar strength could attain higher levels at earlier age (64.8 Kg/cm2 at the age of 28 days). At later ages, the mix strength may exceed 80 Kg/cm2 which is considered very promising.

On the basis of the results obtained herein, a modification for the current Siwan mortar that is currently used by the builders to bond the Karsheef particles together is proposed. It is proposed to orient Ecolodges in Siwa Oasis on the East-West direction. Reduce size and number of windows facing sun and protect with traditional architectural elements and use appropriate vegetation around ecolodges to provide shade. Concomitantly, Ecolodges constructed in Siwa Oasis should have the architectural style and identity of the oasis to preserve the personality of the oasis.

Recommendations for further research

More experimental data on the actual performance of Karsheef stones bonded together with the new binder is quite essential based on the initial promising results achieved from this research. Additional tests are required at later ages (post occupancy evaluation) to verify the strength of the proposed new binder. In addition, other properties of the new proposed binder rather than the compressive strength should be tested. The flexural behavior of the new binder when reinforced with the reeds so called "Sommar" can be very helpful. Last but not the least, the establishment of research and training institutions devoted to desert environmental studies, groundwater research, and agricultural sciences in Siwa Oasis should be considered by the government.

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