WATER-EFFICIENT DESIGN GUIDELINES FOR ECOLODGES ALONG EGYPTIAN COASTS

Teaching assistant: **Ahmed K. Mohamed**

Department of Architecture, Faculty of Engineering, Ain Shams University, Egypt

Abstract

The increasing awareness of the accelerating rate of depletion of water resources is resulting in the high level of demand for water-efficient buildings. The design of ecolodges has a tremendous impact on the environment and natural resources. Water-efficient design guidelines reduce water use and pollution. Two main categories for these guidelines are "Site selection and planning" and "Architectural design". Sustainable building design should be based on local environmental characteristics, social habits, cultural background and achievement of durability, function and resource efficiency. This paper proposes a water-efficient design process for ecolodges along the Egyptian coasts according to Tourism development plans, water availability, economics and future needs. The research also defines the different suitable water-efficient guidelines for designing ecolodges based on their locations and different prototypes used in these coastal regions.

Keywords

Water conservation, Water efficiency, Egyptian coasts, Ecolodges, Water-efficient guidelines, Architectural design, Site selection and planning

1. Introduction

Water is becoming scarce not only in arid and drought prone areas, but also in regions where rainfall is relatively abundant. In water scarce regions, as is the case for the Middle East and North Africa regions, that share averages 73% of the total water resources (The World Bank 1992). This situation illustrates that not only the potential water availability in these regions is low but that sustaining an increased demand requires innovative approaches to cope with water scarcity. Reasons for water scarcity are:

- Increasing world populations, at present, 3.3 billion people live in urban centers across the globe. By 2030 this number is predicted to reach five billion, with 95 percent of this growth in developing countries. [1]
- Global warming, a rise in average temperature caused by Global Warming can alter water resources. These impacts are change in amounts, places and patterns of rainfall; leading to more flooding and more runoff during the rainy season, but also less water held as snow and ice in the mountains for use in the dry season, melting of

[1] U.N. (2008). *The Millennium Development Goals Report.* New York: United Nations.

mountain glaciers and Saltiness of coastal aquifers due to the increase in seawater intrusion. Some studies show that Nile flow may decrease by 60%. [2]

- Pollution, many developing nations possess poor water-supply infrastructure and their industries and cities continue to pour wastes into local waters.

1.1. Current water usage

Currently towards 35% of human water use is unsustainable, humans currently use 40-50% of the globally available freshwater in the approximate proportion of 70% for agriculture, 20% for industry, and 10% for domestic purposes and the total volume is progressively increasing.[2] Drinking water consumption for nonresidential buildings is heavily dependent on use. Hotels have a proportionally higher requirement that can be accounted for, primarily, through washing and catering needs.

1.2. Water shortage in Egypt

Egypt faces increasing water needs, demanded by a rapidly growing population, increased urbanization and the agricultural policy. In Egypt, although the governorates that are located near the River Nile do not experience water deficit, some areas have been identified as having a crucial situation regarding water supply. These areas concern Sinai, the Red Sea coast and Northern Desert coast, where economic development is primarily based on water availability. [3]

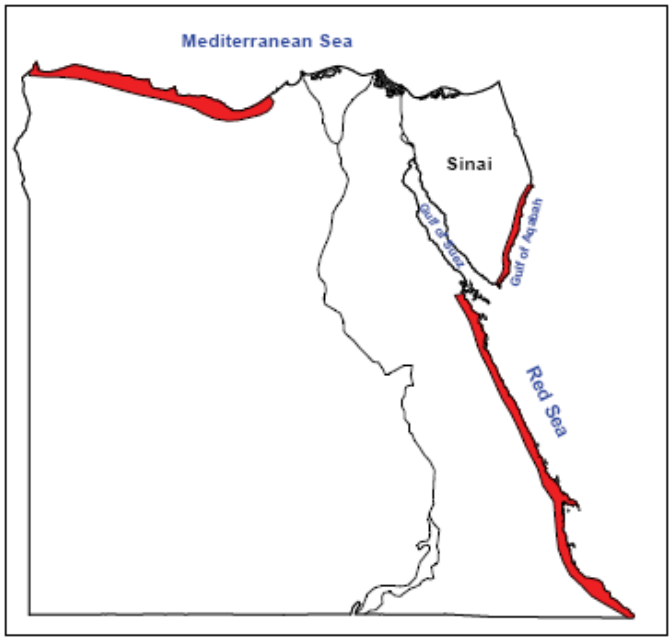

Figure 1 Areas facing water shortage **(INECO, March 2009)**

[2] webofcreation. (n.d.). *Earth Problems/water*. Retrieved 2009, from webofcreation: http://www.webofcreation.org/Earth%20Problems/water.htm

[3] INECO. (March 2009). *Institutional framework and desicion-making practices for water management in Egypt.* International Consultants Egypt.

Water resources in Egypt are becoming scarce; nowadays Egypt belongs to "High water stress" countries with more than 75% of land in water stress.[4] Egypt is facing increasing water needs due to its rapidly growing population and increased urbanization.

Governorate	Tourism sector	Agriculture sector	Population sector	Industry sector	Total water demand
Red sea	130,551	1,020,000	71,000	113,600	1,335,151
South Sinai	93,272	34,000	14,000	22,400	163,672
North Sinai	0	6,992,100	57,000	91,200	7,140,300
Matrouh	0	10,676,000	86,000	137,600	10,899,600
Annual total	80,576,280	6,739,956,000	82,080,000	131,328,000	7,033,940,280
Percentage	1.15%	95.82%	1.17%	1.87%	

Table 1 Water requirement for different sectors in 2017 **(INECO, March 2009)**

1.3. Tourism development statistics in Egypt

The geographic position of Egypt, its natural assets and old civilization have been the basis for the development of tourism, where the combined effort of the State and the public was concentrated. In 2005 the total number of visitors was estimated at 8.7 million. [5]

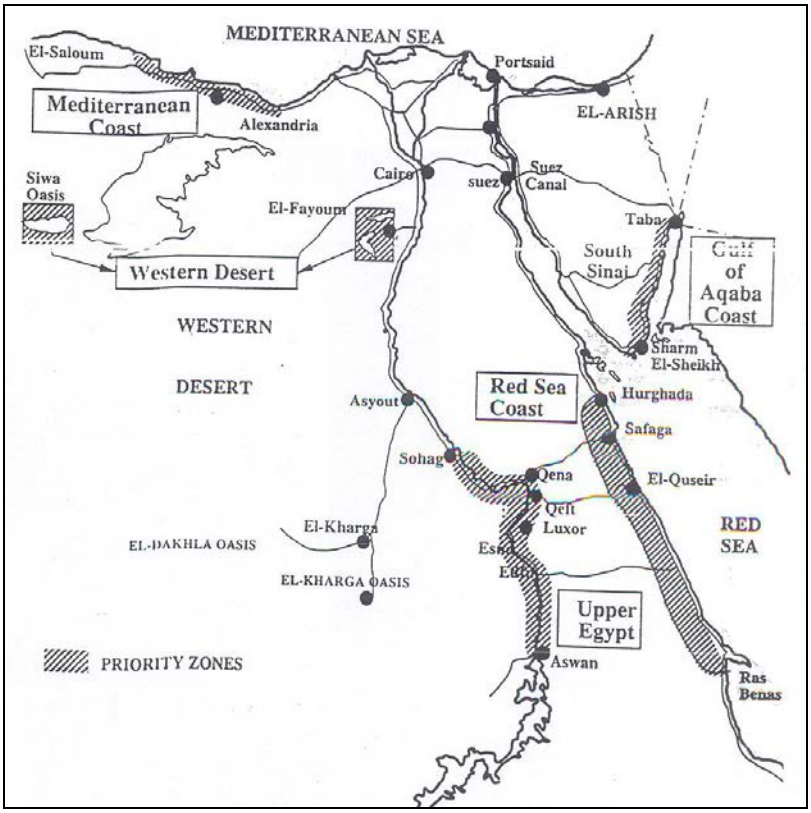

Figure 2 Egypt's priority zones for Tourism development **((TDA), 1995)**

[4] Maczulak, A. E. (2010). Green technology. In A. E. Maczulak, *Conservation: Protecting Our Plant Resources.* New York: Facts On File, Inc.

[5] Aquastat. (2005). *Irrigation in Africa in figures.*

The economic impact of the downturn in tourism activity as a result of these upheavals is quite substantial, especially in case of high frequency and severity of occurrences, which do strongly influence the risk perception of prospective travelers and tourism expansion.

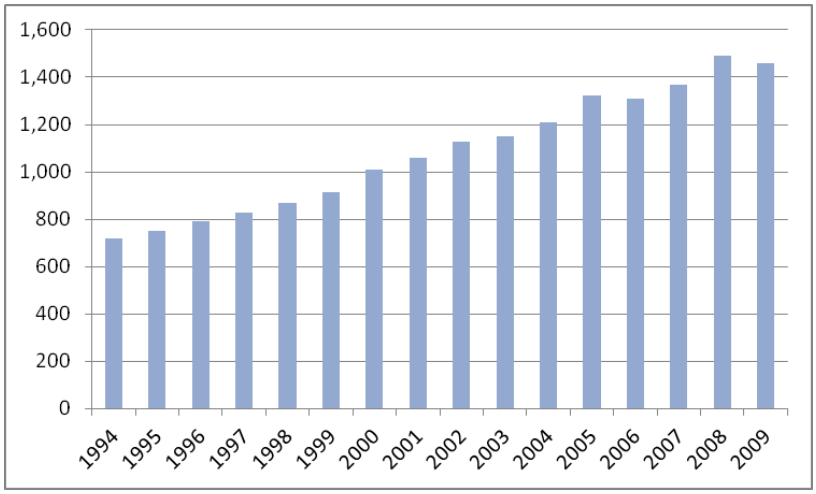

Figure 3 Hotel growth in Egypt by year **(Hotels Supervision Sector, 2009)**

1.4. Water-efficient architecture

According to the definition of Green Building as "building methods and materials that conserve energy, water and resources, use low impact materials, maximize longevity and durability, minimize waste, recycles other buildings and makes buildings and homes healthier" [6], There are two water-saving approaches that can reduce water consumption in buildings:

- Water conservation: Water conservation is defined as "Improved water management practices that reduce or enhance the beneficial use of water in order to reduce water loss, waste, or use".[7]

- Water efficiency: Water efficiency is defined as "The accomplishment of a function, task, process, or result with the minimal amount of water feasible". Water efficiency differs from water conservation in that it focuses on reducing waste, not restricting use.[8]

[6] El Feky, U. M. (2006). *Toward Applicable Green Architecture : An Approach to Colonize the Desert in Egypt.* Eindhoven: Universiteitsdrukkerij, Technische Universiteit Eindhoven.

[7] wikipedia. (n.d.). *Water conservation*. Retrieved 2010, from wikipedia: http://en.wikipedia.org/wiki/Water_conservation

[8] wikipedia. (n.d.). *Water efficiency*. Retrieved 2010, from wikipedia: http://en.wikipedia.org/wiki/Water_efficiency

1.5. Sustainable design principles for ecolodges

The ecotourism industry is at a crossroads in its development. However, it also has led to numerous problems, and placed undue pressures and threats on the natural resources that sustain it. From these often-costly lessons, the benefits of ecotourism can only be sustained through well-planned and carefully implemented projects that place the long-term wellbeing of the natural resources and local communities as a top priority.

An ecolodge is an accommodation facility that satisfies at least five of the criteria listed below, three of which must embody the main principles of ecotourism; that of conservation of neighboring lands, benefits to local communities and interpretation to both local populations and guests: [9]

1. Helps in the conservation of the surrounding flora and fauna.
2. Endeavors to work together with the local community.
3. Offers interpretive programs to educate both its employees and tourists about the surrounding natural and cultural environments.
4. Uses alternative, sustainable means of water acquisition and reduces water consumption.
5. Provides for careful handling and disposal of solid waste and sewage.
6. Meets its energy needs through passive design and renewable energy sources.
7. Uses traditional building technology and materials wherever possible and combines these with their modern counterparts for greater sustainability.
8. Has minimal impact on the natural surroundings during construction.
9. Fits into its specific physical and cultural contexts through careful attention to form, landscaping and color, as well as the use of vernacular architecture.
10. Contributes to sustainable local community development through education programs and research.

So, the aim has been to provide a framework for the design, development and operations of future lodges such that they uphold the social and ecological integrity of their given environments, and thereby allow for sustained benefits from ecotourism without damaging or destroying the very natural resources on which they depend.

2. Site Selection and planning

Careful, well-researched master site planning, and ecologically and socially conscious site design is crucial to creating harmony between tourism developments and environmental/cultural protection. Preserving the special characteristics of a place requires an in-depth understanding of the natural systems on the site, and the cultural responses to

[9] Mehta, H., Báez, A. L., & O'Loughlin, P. (2002). *International Ecolodge Guidelines.* Burlington, Vermont USA: The International Ecotourism Society.

that environment's history, opportunities and constraints. Therefore, the site planning and design for an ecolodge must first of all safeguard the sustainability and conservation of the area's natural assets and cultural heritage, and improve where possible on impacts that may already be present on the site.

A fundamental goal for any "eco" oriented project is that the development of the site must leave the site better off after development than before. The scope for reforestation, water resource enhancements, soil enrichment and wildlife protection and restoration programs is often limited by funds and broadened by the availability of voluntary help. These factors should be taken into account during planning stages once the extent of voluntary work is established.

2.1. Site Evaluations and Selection

The main aspects of site selection are discussed as followed:

- When locating an ecolodge, consider the quality of the surrounding cultural and natural environment, site access, sewage disposal, water supply and impact on the neighboring ecosystem. [9]

- Choose the most adequate location for an ecolodge based upon a comparative analysis of alternative sites. [9]

2.2. Site Inventory and Physical Analysis

2.2.1. Climate

Carefully analyze the climatic factors of the site such as: [9]

A. Temperature
   - Monthly temperature variations: mean, maximum and minimum.
   - Temperature variations between day and night.
   - Frequency and mean duration of temperature extremes.
   - Location variations (north and south slopes aspects).

B. Precipitation and humidity
   - Monthly and yearly mean precipitation (measured in mm).
   - Identification of dry and rainy seasons.
   - Absolute and relative humidity.
   - Snow accumulations and disposition pattern.

2.2.2. Land

Carry out a detailed analysis of the following land characteristics: [9]

A. Soils
   - Dominant types of soil.
   - Resistance and compaction of soil: fitness for different types of foundation and construction.
   - Thickness of the different layers, degree of maturity, texture, strength, susceptibility to compaction, presence of organic materials, presence of alluvial soils, degree of permeability, fertility, rockiness, erosion, etc.

B. Hydrology
   - Presence of rivers, streams, wadis, lakes, marshes, reservoirs, or oceans (or distance to these features).
   - Subterranean waters.
   - Degree of water pollution.
   - Risk and frequency of floods.
   - Depth of water table.
   - Sources of potable water.
   - Potential for making use of hydroactive energy systems.
   - Soil recharge characteristics.

2.2.3. Vegetation [9]

- Native and introduced vegetation (exotic species).
- Endemic (peculiar to the area), characteristic and threatened flora species.
- Identification of focal (flagship) flora species (if any) from the ecotourism attraction viewpoint.
- Tolerance or susceptibility to different types of disturbance, such as trampling, fire, etc.
- Possible measures for regenerating local native vegetation.
- Potential for integrating site plan and architectural design with surrounding native vegetation and plant communities.

2.2.4. Analysis of Cultural Features [9]

- Find noteworthy local cultural elements, both past and present:
    - Traditional settlements.
    - Potential for integrating design with cultural environment.
- Understand and respect the main cultural elements and traits of the region.

2.3. Master Site Planning

Landscape architects, planners and architects (with a strong ecological and environmental foundation) are among the best trained to design a sustainable development in nature-based areas. They bear a special responsibility for the design of facilities that are to be developed in pristine, ecologically rich areas. [9] The main aspects of master planning are:

- Using zoning to define allocation of areas for different uses and services based on the limits of acceptable change of the natural and cultural resources as well as other biophysical and climatic conditions. It must also support efforts to conserve the area's natural and human resources and also contribute to enhance the quality of the ecotourist's experience. [9]

- For each of the zones, plan for a specific density related to buildings and their primary uses. Examining relative merits of concentration versus dispersion, remembering that natural landscape values can normally be best conserved if the physical plan is carefully dispersed but also, inversely, knowing that by concentrating buildings and other structures helps leave more available undisturbed natural zones. Again, the challenge is striking the right balance. [9]

- The provision of multimodal access corridors and the use of road surfaces that are local and non-petroleum based so as to increase recharge of water and reduce runoffs. [9]

2.4. Site Design

The main aspects of site design are discussed as followed:

- In hot localities, if you include an area for swimming, consider a natural or semi-natural area, like a lake, artificial lake, river, or the sea, but be sure there are no immoderate risks (noxious fauna, excessive sea waves or undertow, etc.) and avoid disturbance to aquatic fauna. [9]

- Limit the impervious cover of the ground to the minimum needed, especially around existing trees. Excessive areas for driveways should be avoided. A pervious surface, such as shell, turf, stone, brick or marl is recommended. [9]

- Make sure that all trails respect location, growth and expansion patterns of the local flora. [9]

- Use vegetated swales as a natural way of conveying concentrated runoff. Compared to closed structural systems, this open drainage increases plant variety, reduces need

for irrigation water, reduces drainage velocity and erosion and needs less maintenance. [9]

- Make managing runoff an important facet in your ecolodge. If drainage controls are implemented at the beginning of site planning they can be integrated economically in the overall development. The concept is to capture rainwater from roofs and filter runoff from impervious pavements with minimal disturbance to natural drainage patterns. [9]

- Do not directly channel runoff into water bodies or marshes, conservation areas or other impervious surfaces without adequate filtration. Divert artificial runoff into existing natural swales. [9]

2.5. Landscape Design

The following are some main aspects for landscape design:

- If native plant populations exist on a selected ecotourism site, it is crucial that they be conserved. [9]

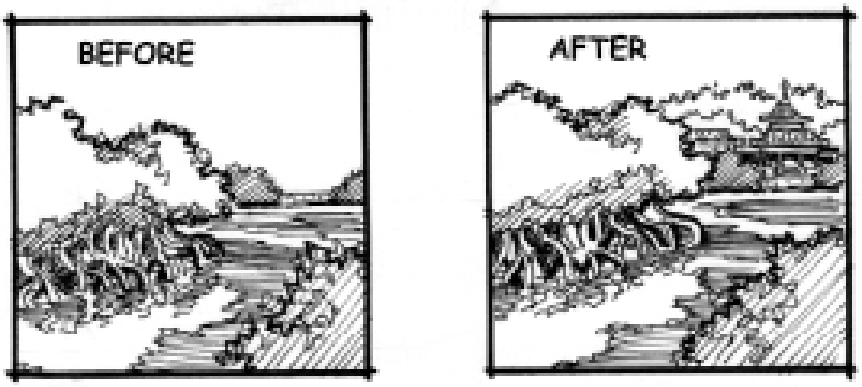

Figure 4 Existing plant before and after an ecolodge siting **(Mehta, Báez, & O'Loughlin, 2002)**

- Use salt-tolerant plants in areas close to the ocean. Salt from the ocean is transported in the air and deposited either on the vegetation or in the soil. Planting trees helps to lower the saline ground water table, thus protecting surface vegetation from excess salt. [9]

- Two goals for all planned plantings are that invasive species should never be introduced, and plantings should need only the minimum of maintenance, particularly in terms of water and trimming, once they are established. [9]

3. Architectural Design

The responsive design of the ecolodge is at the core of offering the client an environmentally responsible travel experience. Existing ecolodges worldwide have been able to demonstrate a remarkable level of sensitivity to both the local (site) environment and surrounding area.[10] The main aspects of architectural design are:

- Maintain, restore and enhance the natural ecosystem: It is more important than achieving dramatic or impressive architectural expressions. Define the easiest, fastest, most economical and least destructive way in which your ecolodge may be built, at the design stage. Make the most of all-available local natural resources and plan for long-term economic return. [11]

- Create an architectural style always consistent with an environmental philosophy and with the goals of ecotourism, avoiding design contradictions. Local traditional building forms and materials may provide clues to efficient and ecologically sensitive design. Also minimize negative environmental impacts by designing an ecolodge with rational and economic use of space. [11]

3.1. Context and Aesthetics

Using clues from the local landscape for materials, building forms and siting such as:

- Conceive the shape of the roof to be a function of the site's precipitation regime (i.e. in places where it rains or snows abundantly use a pronounced pitch; where it is predominantly dry use a flat or domed roof). The degree of overhang or extension of the roof beyond the building line can provide shelter from sun or rain. [11]

Figure 5 buildings emerged like a geological formation **(Mehta, Báez, & O'Loughlin, 2002)**

[10] USAID. (JUNE 2008). *LIFE Red Sea Project - Best Environmental Practices for Desalination Plants in the South Red Sea Region of Egypt.* Chemonics International.

[11] (Mehta, Báez, & O'Loughlin, 2002)

- Whenever possible, develop in previously disturbed sites. Redevelopment requires minimal disturbance of natural systems since the disturbed area may already be impacting the site. Suitable old or traditional buildings on the site should be converted into ecotourism facilities. Conversion of existing facilities is one of the lowest impact design techniques. [11]

- Locate pasture and corral areas for any horses, camels, and other grazing stock away from natural sources of potable water or watersheds. [11]

- The colors used for the ecolodge should be drawn from shades found in the surrounding elements — leaves, barks, rocks, sand, mountains, etc., (commonly referred to as earth tones) — that should soften the presence of the built form within the environment. [11]

- Local regulations for colors: All buildings of all types are painted white or use stone of local-tone (beige). All the woodwork - whether doors, windows, walls, partitions, wooden pergolas or wind catchers - can be painted cyan or blue in all their different tones. All external woodwork in the building can be left as varnished natural wood. [12]

- Integrate the lodge into the surrounding landscape through the planting of various indigenous trees and shrubs whenever and wherever possible. Landscaping should be guided by the patterns of the existing natural landscape. Native vegetation (e.g. shrubs and trees) and rocks should be laid out in an informal, natural manner. [13]

- Base your design on local building techniques and forms (if there are any) and use local cultural images as much as you can. Think about: the form of the built structure and traditional materials and technology used in their construction and spatial relationships between and within structures. [13]

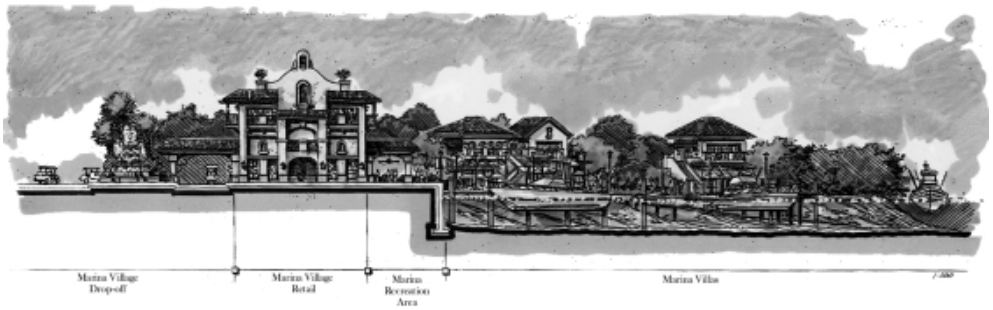

Figure 6 An ecolodge example which respects the cultural context of its surroundings

[12] (TDA), T. D. (1998). *Comprehensive tourism development plan for the Gulf of Aqaba - South Sinai (Arabic).* Giza: Tourism Development Authority (TDA).

[13] (Mehta, Báez, & O'Loughlin, 2002)

(Mehta, Báez, & O'Loughlin, 2002)

- Construction, interior furnishing and decorating (which should be discreet) should always take advantage of local materials and hand labor (including native artists and artisans), if they exist. [13]

3.2. Areas and standards for Ecolodge Spaces

3.2.1. Built Area

The ecolodge development, including accommodation units, food and beverage services, and utilities should be contained within 20 percent of total surface. The remaining recreation, access, and maintenance facilities will be strategically located throughout the rest of the site. [14]

3.2.2. Accommodation Density

The ecolodge room density varies depending on star rates: [15]

- A 3 star lodge at 9 - 20 rooms/feddan.
- A 4 star lodge at 6 - 17 rooms/feddan.
- A 5 star lodge at 4 - 14 rooms/feddan.

3.2.3. Building height

The maximum height is two floors. Some investors may prefer a 2-story option because it has a smaller footprint, provides an interesting spatial arrangement, and can offer guests better views, particularly towards the sea or other vistas. The two floor limit may be exceeded for certain facilities such as roof patios or observation decks. [14]

3.2.4. Room water fixtures

The minimum bathroom will have a combination tub-shower, a lavatory and a water closet. However, two lavatories may be right in the bathroom itself, they may be pulled out into a dressing area, or one lavatory may be placed in the bathroom and another outside the bathroom. Some hotels also introduce the bidet in bathrooms. [16]

[14] ((USAID), MARCH 2008)
[15] ((TDA) T. D., 1998)
[16] De Chiara, J., & Callender, J. (1987). *Time Saver for Building Types - Secnd Edition.* Singapore: McGraw-Hill.

3.2.5. Guest Circulation, Administration, and Services Areas

Ecolodges are increasingly popular with the fast growing health and wellness market. This suggests that health facilities may be added. Facilities to be considered are: [17]

a) Office, hallways, lobby, storage
b) Retail space
c) Restaurant and lounge
d) Resource center, reading room,
e) Health center (SPA).
f) Locker rooms with toilet facilities and showers.

3.2.6. Food and Beverage Area

The following are some main aspects for food and beverage area design:

- The dishwasher is usually placed close to the dining room area so that the dishes can be disposed of as soon as the waiter or busboy enters the kitchen. The dishwashing area is, not only noisy but also a rather untidy operation, so it must be kept fairly isolated from the actual cooking and serving area. [16]

- It is an excellent idea to have toilets and washrooms for kitchen help, so that it isn't necessary for them to return to their locker rooms, which may be at some distance. [16]

- In case there are several kitchens, preferably on a horizontal core, so that there is the possibility of vertical distribution of food from the preparation areas which would probably be on the lower level. [16]

3.2.7. Laundry Facilities

A hotel laundry that does its own uniforms and flatwork (sheets, pillowcases, linens, etc.) requires a good-sized space for washers, dryers, drum ironers, and various pressing machines-each suitable for its own type of flatwork, uniforms and guests' laundry, and men's and women's wearing apparel. [16]

Larger hotels will maintain their own cleaning department for dry cleaning and pressing of woolens and similar garments. Such a cleaning and valet service is usually a part of or close to the laundry area, and it is under the supervision of the laundry manager. [16]

[17] ((USAID), MARCH 2008)

3.2.8. Mechanical Spaces

The boiler or mechanical room will include the various pieces of equipment for heating and cooling as well as all the tanks and pumps to keep all the mechanical systems in operation. [16]

3.2.9. Recreation Facilities

The mix of recreation facilities will depend on the preferences of the investor. Those that would be acceptable include tennis court, games area, and a saltwater swimming pool. The latter would have the most significant impact on the environment (pump and filtering); however, with the use of salt water, evaporation control, and solar generated motors this can be minimized. [18]

A saltwater swimming pool requires a surface area of 2–3 m^2 per swimmer. A hot tub should be adequate for 8–10 persons.[18] Some aspects for swimming pools are discussed as followed:

- The size, shape, and siting of swimming pools and equipment enclosures must be carefully considered to achieve a feeling of compatibility with the surrounding natural elements and the architecture of the lodge. [19]

- Carefully site the pool's plant room as this can minimize routing and ducting of services and increase heat recovery potential. [19]

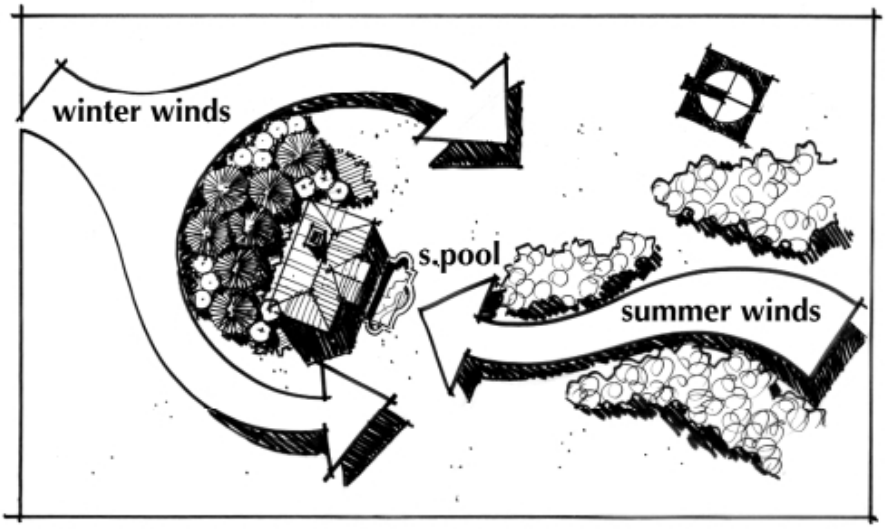

Figure 7an example of a swimming pool orientation **(Mehta, Báez, & O'Loughlin, 2002)**

[18] ((USAID), MARCH 2008)
[19] (Mehta, Báez, & O'Loughlin, 2002)

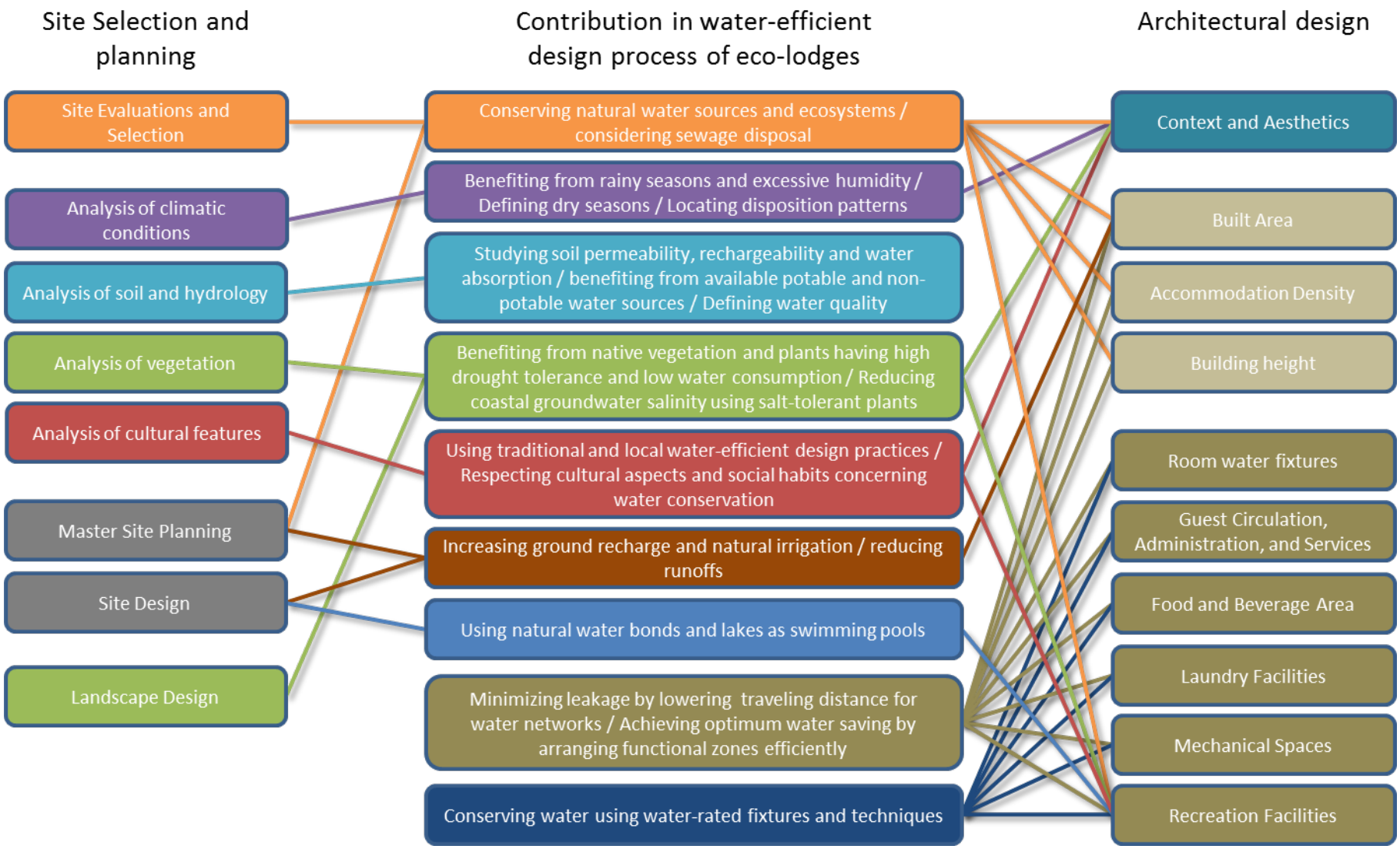

Figure 8 Research summary chart

4. Conclusion

According to international Eco-tourism associations, Ecolodge should cause minimal or no damage to the local environment and communities. Main considerations for ecolodges are conservation of nature, using local architecture and labor, minimizing the use of energy and water, managing waste, minimizing negative impacts on nearby villages and supporting the local community in terms of education, development, etc.

Although there are many opportunities for water conservation, the wide availability of mains water, sewage and storm water drainage connections means that water issues are rarely considered in building projects. However, there are benefits to such considerations at the earliest stage in design and refurbishment, and these are increasingly a requirement on the part of architects and planners.

The Egyptian coasts are considered the most regions in Egypt facing an extreme water shortage. Although they have a huge amount of saline water located in seas, lakes and underground brackish aquifers, this water needs excessive desalination and treatment processes which require high initial costs and energy consumption.

Designing ecolodges in such regions should be highly water-efficient. Main outputs that can be achieved by applying water-efficient guidelines for designing ecolodges include:

- Conserving natural water sources and ecosystems / considering sewage disposal.
- Benefiting from rainy seasons and excessive humidity / Defining dry seasons / Locating disposition patterns.
- Studying soil permeability, rechargeability and water absorption / benefiting from available potable and non-potable water sources / Defining water quality.
- Benefiting from native vegetation and plants having high drought tolerance and low water consumption / Reducing coastal groundwater salinity using salt-tolerant plants.
- Using traditional and local water-efficient design practices / Respecting cultural aspects and social habits concerning water conservation.
- Increasing ground recharge and natural irrigation / reducing runoffs.
- Using natural water bonds and lakes as swimming pools.
- Minimizing leakage by lowering traveling distance for water networks / Achieving optimum water saving by arranging functional zones efficiently.
- Conserving water using water-rated fixtures and techniques.

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ارشادات التصميم ذو الكفاءة المائية للنزل البيئية على السواحل المصرية

ان زيادة الوعي بالمعدل المتسارع لنضوب الموارد المائية تؤدي الى زيادة الطلب على المباني عالية الكفاءة المائية. فتصميم النزل البيئية له تأثير بالغ على البيئة والموارد الطبيعية. تعمل ارشادات التصميم ذو الكفاءة المائية على تقليل استخدام المياه وتلوثها. هناك فئتان رئيسيتان لهذه الارشادات هي "اختيار الموقع وتخطيطه" و "التصميم المعماري". ينبغي أن يستند تصميم المباني المستدامة على الخصائص البيئية المحلية، والعادات الاجتماعية، الخلفية الثقافية وتحقيق الوظيفة، والقابلية للتحمل وترشيد استهلاك الموارد. تقترح هذه الورقة عملية التصميم ذات الكفاءة المائية للنزل البيئية على طول السواحل المصرية وفقا لخطط التنمية السياحية، وتوافر المياه، والاقتصاد والاحتياجات المستقبلية. البحث يعرف أيضا الارشادات المختلفة لترشيد المياه المناسبة لتصميم النزل البيئية اعتمادا على مواقعها و نماذجها المختلفة المستخدمة في هذه المناطق الساحلية.