Keywords: Hammām, Sustainability lessons, traditional building, vernacular architecture, low energy design, sustainable design.

Abstract
The Islamic bathhouse; hammām, is a traditional building type which has played an important role in providing a key washing facility for the population living in the North African médinas. It was also used to play important socio-economic and environmental roles within each neighbourhood and was associated with a rich intangible heritage.

As a building type, the hammām has evolved from the small Roman Bath or Balnéa and relies heavily on key services such as water distribution and drainage as well as heating systems. The water is traditionally heated in the furnace, the steam is released into the hot room and the smoke and heat from the furnace travel under the floor (through a hypocaust) providing an efficient heating system for the bathing spaces. Architecturally, the Islamic public baths present a rich variety of spaces following a sequential organization of spaces; from cold to warm to hot rooms, passing by intermediate thermal zones. Hammām buildings constitute the perfect illustration for architecture of liminality. They also present ingenious vernacular construction techniques of domes and vaults using local building materials with high thermal mass, renders and plasters that respond to varying levels of heat and humidity. At the urban scale, hammāms occupy irregular plots of land and are well embedded into the traditional urban fabric of the medina. Their furnace used to act as neighbourhood recycling centre for local by-products such as wood chippings, olive stones and combustible rubbish.

Based on surveys carried out by the authors on the historic hammāms of Cairo, Tripoli, Tunis and Marrakesh, the paper highlights the valuable lessons of sustainable architecture that this building type provides. A number of design guidelines are proposed on the basis of the challenges facing the hammām today and the opportunities it presents for the development of contemporary sustainable public baths in the 21st Century.

1. Introduction
In a rapidly changing, “globalized” world, all existing traditional institutions are being challenged. In developing countries and traditional societies these new outside pressures can be quite threatening to established values and ways of life. It is increasingly acknowledged that the most harmful and most dangerous contributions to the “un-sustainability” of the planet have come from the most “advanced” developed countries. On the other hand, developing countries that have not yet fully succumbed or fully succeeded in adopting the Western program of globalization are still producing the lowest per capita load on the environment. Hence they are still considered as supporting “sustainability and sustainable development” (Cole, 2005).

What is largely missing from the “development issue” is that these traditional cultures, having developed over centuries and having retained many of their original patterns and structures, are a lot closer to a sustainable relationship with their socio-cultural, economic and natural environments than are modern “advanced” nations.

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Any historic town and city had developed and maintained a balanced relationship with the resources gathered from its surrounding countryside, nearly sustainable resource patterns were always a precondition for long term survivability. These patterns of resources-use over hundreds of years would become embedded in the local craft traditions and the local culture. In a world that has long since abandoned the ancient wisdom embodied in traditional cultures and replaced it with a system of temporary prosperity but longer term un-sustainability, there is much to learn from these traditional patterns and wisdom traditions in our postmodern quest for sustainability.

Architectural studies of the Mediterranean traditional settlements and in particular those of the Islamic historic cities or médinas illustrate examples of liveable towns and cities that were in harmony with their environment and provided many lessons of sustainability. The buildings, the streets and squares have not been “designed” in the modern sense, but have evolved often over thousands of years and through a number of different civilizations, cultures and historic periods. Through them all, the rich and varied urban fabric has been maintained and rebuilt and has been highly responsive to human needs.

2. Defining Sustainability

In 1987, the World Commission on Environment and Development developed a definition of sustainability that was included in its findings, which became known as the Brundtland Report. It stated that: Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland report, 1987). Although this definition has become widely publicized, the term sustainability is not limited to one precise definition. For the purpose of this study, the definition of the term “sustainability” adopted in this paper relates mainly to what is sustainable architecture and urbanism. Sustainable architecture is a general term that describes environmentally-conscious design techniques in the field of architecture. However in our study, it is framed within the larger concept of sustainability and the pressing socio-cultural and economic issues. In this framework, sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. Furthermore it brings together environmental, socio-cultural and economic parameters in a tri-dimensional holistic view (figure 1).

A sustainable city/town is where the given region, on a net basis, is again operating within its fair share of the earth’s bounty on a regenerative basis. As we have no modern models that we may observe where this condition prevails, it may be useful to observe those places where at least sustainability may have been practiced, even though it was not identified as being the “sustainability concept” and “sustainability term”(Levine, 2008).

3. Sustainable architecture from the past

Architects and urban planners over the world are trying to come to terms with the challenges that the future holds for us. New ‘green buildings’ and urban designs aimed at reducing the need for motorized travel are being advanced as a solution to the crisis of our age characterised by climate change and ever depleting energy and resources. However, two recent major governmental studies in Europe (Levine, 2008) are beginning to point in a different and intriguing direction. In certain respects, traditional buildings and traditional urban patterns tend to perform remarkably better in environmental, socio-cultural and economic aspects, than their contemporary counterparts. It appears they have other notable advantages as well. Traditional buildings are believed to embody numerous intelligent design features, emerged and refined through the historical process of adjustment to local climatic conditions and social functions (Mahdavi, 1996).

Their efficiency appears to be an outcome of several factors. Firstly that traditional buildings have served the city and the community long enough to justify the carbon emissions that went into building them in the first case; secondly that they have evolved low energy approaches to comfort and commodity; thirdly, that these
buildings show remarkable “repair-ability” and adaptability over time to a variety of needs; and fourthly, that positive associations have been found in terms of likeability, cultural affinity and people’s desire to maintain traditional buildings. It is hence desirable that such positive attributes of traditional buildings could be incorporated in future development of built form. To tap into this potentially rich source of design knowledge, a deeper understanding of the working of such environmentally, socially, culturally and economically adapted buildings is necessary.

The present paper attempts to introduce specifically, the lessons in sustainability (environmental, socio-cultural and economic) embedded in the traditional bathhouses of North Africa in Cairo, Tunis Marrakesh and Tripoli (Libya). This work is part of an AHRC funded research project under the title of “The Historic Islamic Baths of North Africa and their Survival into the 21st Century”, which aims to complete a comprehensive survey of the historic hammâms and develop an understanding of their current usages and their future potential (Sibley, M 2007).

4. A sustainable city: the Islamic médina

The architectural community has had a strong and continuing interest in traditional and vernacular architecture. This has been rekindled by the need to develop an architecture that works with local climate, community and culture rather than against it, to create more sustainable buildings. Previous research and existing publications on traditional or vernacular architecture have followed an anthropological or archaeological approach, whereas books on climatic design and sustainable architecture tend to refer to contemporary principles and built precedents without direct reference to past experience. Traditional architecture and urbanism offer several lessons to contemporary architects and designers to inspire them when designing new buildings to make them compatible with sustainability concepts. One of the most prominent examples of sustainable cities is the médinas or the Islamic cities.

The structure of the medina in many Islamic cities such as Tunis, Tripoli and Cairo, is of a very dense, tightly packed system of courtyard buildings organized along narrow streets and alleyways (figure 2). The streets are too narrow for cars and the major streets are lined with shops, workshops and public facilities. There no car pollution as these cities evolved at times when transport was done using animal such as donkeys, horses and camels. All buildings are inward looking onto courtyards which provide good access to natural light and ventilation and provide both visual and acoustic privacy. High residential densities are achieved within a mixed use tightly knit urban fabric. There are few if any windows on the street. The entrances on the streets and alleys are usually small (even the entrances to the larger courtyards) and there is little if any public space outside the private or semi-private courtyards.

The mosques and madrassas (Islamic schools) will have sometimes very large courtyards, but these are experienced as semi-public spaces with special entrance gates and are not experienced as being a part of the continuous public paths of the medina. High density and low buildings allow all structures to benefit from their location and orientation towards natural lighting and ventilation. Therefore less energy is consumed throughout the urban fabric. Hence lower footprint ratios are produced in these “green cities” as shown in table 1 (The Global Footprint Network, 2007).

Médinas of the Islamic world are the production of successive civilizations, as such is the case in cities around the planet. They were composed of the same urban entities as they responded to the same needs of housing (houses), religion (mosques), education (madrassas or schools), protection (high walls), trading...
(sūqs or markets), and hygiene and cleanness (hammâms or public baths). Public bathhouses were and continue to be a major urban facility in the historic Mediterranean Islamic city, changing its customs, design, forms and shapes throughout temporal eras. The Islamic public bath or hammâms are the successors of the balnéa type of the Roman-Byzantine baths. They have evolved through the different ruling dynasties in the Muslim world.

Table 1: The per capita footprint by country
(The Global Footprint Network, 2007)

<table>
<thead>
<tr>
<th>Country</th>
<th>hectares per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>0.8</td>
</tr>
<tr>
<td>Morocco</td>
<td>0.9</td>
</tr>
<tr>
<td>China</td>
<td>1.3</td>
</tr>
<tr>
<td>Egypt</td>
<td>1.4</td>
</tr>
<tr>
<td>Algeria</td>
<td>1.6</td>
</tr>
<tr>
<td>Syria</td>
<td>1.7</td>
</tr>
<tr>
<td>Turkey</td>
<td>2.1</td>
</tr>
<tr>
<td>World</td>
<td>2.2</td>
</tr>
<tr>
<td>Austria</td>
<td>4.9</td>
</tr>
<tr>
<td>France</td>
<td>5.6</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>5.6</td>
</tr>
<tr>
<td>Canada</td>
<td>7.6</td>
</tr>
<tr>
<td>United States of America</td>
<td>9.6</td>
</tr>
</tbody>
</table>

Studying traditional buildings allow understanding the reasons behind their higher performance towards sustainability levels and the possibility of learning lessons from such traditional developments to help design greener better buildings in the future. Two main issues can be raised and are as follow:

- Traditional buildings (in our case the hammâm) perform better than their contemporary counterparts under certain given criteria, and
- Lessons can be learnt from such traditional built forms to design greener buildings in the future.

5. A Sustainable Building: the Hammâm

5.1. Environmental dimension of Sustainability

5.1.1. Architectural & urban aspects

The historian Nelly Hanna describes the location of the hammâms in Bulâq, a popular district in Cairo, as follows: “The location of the public baths was similar in pattern to that of the sabîls (water fountains). A major criterion for their pattern of location was accessibility to the inhabitants from all sections of town. That was why the hammâms were situated along the main roads in such a way that a bath could be reached within a short walking distance from any part of Bulâq” (Hanna, 1983).

![Figure 3: Photo of a hammâm Sināniya roofscape in Cairo (Authors, 2007)](image1)

![Figure 4: Photo of a hammâm Darghût roof in Tripoli, Libya (Authors, 2008)](image2)

The location of the hammâms in the urban fabric of the Islamic medina is mainly dictated by their accessibility from different quarters of the city and their proximity to the urban water distribution system. They are also part of clusters of key urban facilities as they can be found near mosques, madrassas (Islamic schools), bimârestan (hospitals), sūqs, and caravanserais (figures 3 and 4) and are well embedded in the traditional residential fabric (figure 5). Therefore, their size and form vary as they are never found as free-standing structures but are surrounded by other buildings, reducing the area of their exposed external walls to that of the entrance facade only (Sibley, 2006). Their presence in the urban fabric is more evident at roof level because of the pierced domes and vaults that are specific to them and not found in any other building type (figure 3).
5.1.2. Passive design devices

The heating in the majority of hammams uses hypocaust system. It is fuelled by a material extracted from a special kind of olive kernel after being soaked. This cheap price extract is available at the olive pressing shops found across the Mediterranean countries. The heat produced by this fuel is used for heating up the water that passes later through canals inside the hammam. The water is pumped from the well belonging to the hammam, and sometimes serving the adjacent mosque and madrassa.

In Egypt, and instead of the hypocaust system, the heating system used was based on piping and a followed a gravitational system. This system is used to circulate the water to the bathing spaces and the plunge pools. In one of the earliest descriptions of hammams, Abdel-Lattif al-Baghdadi notes that the furnace has an open dome from which the flames reach a platform with four lead cauldrons (nahāssa in Arabic) also made of copper. The floor of the fireplace is covered with layers of salt since salt conserves heat. Furthermore, the furnace traditionally has other functions which can be considered as good lessons of sustainability in practice. These are the recycling of rubbish and the re-use of the by-products of local traditional workshops as fuel. The other function of the furnace is to cook fava beans (fūl) in special containers. The ash from the furnace added to the traditional wall plasters increases their performance; in fact they developed pozzolanic effects (Fadli & Sibley, 20080).

The hammām derives from its Roman-Byzantine predecessors. However it adopts a more human scale and is more individually focused. Ceilings are low and lighting is dim. This led to an advanced spatial sequencing and to the perfect representation of the “Architecture of Liminality” in the Islamic public baths. In architecture, “liminality” is explored as distinct threshold zones (Tschumi, 1983) that highlight, monumentalize, and herald transition and transformation in physical, sensory, and emotional manners (Repenning, 2003). They present a rich variety of spaces following a sequential spatial organization from cold to warm to hot rooms, passing by intermediate thermal zones (Figure 7). They also illustrate ingenious vernacular construction techniques of domes and vaults using local building materials with high thermal mass and renders and plasters that respond to varying levels of heat and humidity.
The hammām structure uses an ingenious passive architectural devices to develop anabatic air movement (upwards) it is also known as an upslope flow, but also delivers katabatic process of air (downwards movement) which helps heat transfer at transitional sequences (figure 8). Another distinctive feature of the hammāms is the way the domes over the washing rooms are pierced with circular or star-shaped roof lights, forming intricate patterns. Whereas Roman and Byzantine bathhouses are naturally lit with a central lantern at the top of the dome and windows placed at the lower edge of the dome, the Islamic bath houses are characterised by multiple circular or star-shaped openings over the whole surface of the dome and closed by glass caps. These openings consist of pottery tubes built into the domes, closed by glass covers and arranged according to various decorative patterns. Some of these glass bulbs are removable in order to allow for natural ventilation to take place when the bathing spaces are not in use. They allow for daylight to enter the bathing spaces and create a special atmosphere enhanced by the high concentration of steam in the bathing spaces. The steam helps the diffusions of day lighting inside the bathing spaces with reflective and diffusing effects (Figure 9).

In summary, a hammām adopts the following passive architectural dispositions;
1. Use of burying to save energy
2. Use of air stratification to save energy and improve comfort
3. Use of upper openings to restore air circulation in the lobby
4. Clever organization of inner volumes in the passive area including lobby
5. Clever design of the steam room and communication with the warm room
6. Use of heavy stone & brick vaulting to increase the inertia of the building, balance the structural efforts and promote anabatic air movements
7. Use of curved glass lighting devices to cover the passive area and limit overheating during summer, and permit natural daylighting (J Bouillot, PLEA 2006).
5.2. Economic & Socio-cultural dimensions of sustainability, involving local communities

As opposed to the occasional café shop, restaurant or tea house which operate as private businesses, in most places the hammām is managed privately, but owned by the waqf (religious endowment in Islam), a conservative, quasi-public, quasi-religious charitable organization with very old origins in Islamic culture. This ambiguous, in-between status gives the neighbourhood and its citizens a sense of co-ownership in the hammām that other businesses and institutions do not have. This multiple identity makes the hammām amenable to become an institution as well as a place and a space in the neighbourhood for congregation and for the focus of civil society processes. With a paucity of public space in the medina, the hammām, by being less constrained than the more religiously oriented institutional spaces, is poised to become a meeting place, where future-oriented, civil society processes could emerge (Levine, 2008).

The socio-cultural role of hammāms in the North African societies is very important. Tunisia inherited the tradition of using the bath and was given special promotion because of Islam's emphasis on cleanliness, hygiene and good health. Socially, the bath was given a high position, emphasised by the religious requirements in the daily and weekly activities of the society. This can be considered as the religiously-social related role of the hammām. The public bath plays an important role in the social activities of the Muslim community. It is an intimate space for interaction of various social groups. The group strengthens the bonds between its members and allows them to make contact with other groups or individuals. The hammām constitutes a "democratic space" for the local community. Traditionally, the hammām plays a significant role in marrying people. In conservative communities such as those of North Africa, women who are looking for suitable brides for their sons would go to the bathhouse for this purpose. It is also customary, in many parts of the Muslim world, for the new bride to be taken, with her friends, to the hammām where she is prepared, groomed and applied the *Henna* (Herbal paste once applied leaves red/brown colour). The groom is also escorted there, at night, before he meets his bride. This custom still survives mainly in the Maghreb countries; i.e. Libya, Tunisia, Algeria and Morocco (Fadli & Sibley, 2008).

![Figure 9 Men socialising in a hammām](image1)
![Figure 10 Men socialising in a hammām today](image2)

6. Conclusion & recommendations: Preserving a traditional green building; the Hammām

Modern buildings are extremely energy extensive because they rely too much on mechanical and electrical systems for heating, cooling, and lighting. Traditional, vernacular, or indigenous buildings, on the other hand, used little energy for heating, cooling, and lighting, and what energy they did use was natural and renewable. Because modern buildings use about 50% of all energy, they are a major cause of energy depletion, pollution, and global warming. More efficient mechanical and electrical systems are not the primary way of reducing the energy consumption of buildings. Rather, it is the design of the building itself that will have the greatest impact on reducing the energy requirements of buildings. Since regional versions of traditional architecture can help teach us how to build truly low energy buildings, it is important to preserve some of these old buildings in every community so that local architects, builders, and owners can see for themselves what works in that climate and culture. Thus, it is possible to not only get better functional solutions, but also solutions with a local aesthetic and cultural tint (Norbert, 2006). From this traditional knowledge-base can result new buildings that will be neither like present modern buildings nor like traditional ones, but rather a mixture of the best of the new and the best of the old: the hybrid alternative.
It is clear that the hammām as a traditional building type offers a number of sustainability concepts and principles in terms of construction, heating system, water use, natural ventilation and day lighting. Even though regional variations exist, and which we could not target in this short study, there are common opportunities that can be developed based on the four classic elements (water, air, fire and earth) around which the architectural analysis developed, such as water storage and management and the use of solar energy at the scale of a neighbourhood. Today, the survival of these historic structures is jeopardized, not only by the lack of awareness of their historical importance, but also by the lack of appropriate restoration practices with a clear re-use plan. Safeguarding this building will help creating a basis for Built Environment professionals in general and architects in particular to promote traditional wisdom in contemporary and future developments.

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Note, The International Journal of Middle Eastern Studies IJMES transliteration system has been used in this paper.

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