BUE - FISC – 0025

GREENING THE BUILT HERITAGE AND ITS ECONOMIC IMPACT

Karim M. Ayyad
Asst. Lecturer of Green Architecture, Dept. of Architecture, Faculty of Engineering, October University for Modern Sciences and Arts, 6 October, Egypt
karim.ayyad@yahoo.com

ABSTRACT:

***T**his paper aims at presenting the idea of greening the built heritage and investigating its economic impact on heritage and the processes of restoration. The built heritage has been always the main pillar of civilizations and the symbol representing its culture. Even other sorts of cultural heritage used to nourish around or within the urban, rural or architectural landscape. However, in many civilizations the environmental factor was not the main determinant of building design. This caused the loss of numerous pieces of human history. Moreover, the rapidly changing climate has put more pressure on historic buildings. Hence, the new approach of preservation of historic buildings discussed in this work takes into consideration the elimination of any previous or recent conflicts between the historic buildings and their environmental context, and by doing so, getting rid of the main cause of their deterioration.*

It also argues that greening the built heritage is economically feasible, as the economic aspect is the key measure used to test the applicability of this approach and evaluate its impacts. Consequently, this approach implies adapting our heritage to the quickly changing environmental factors, by introducing minor unnoticeable design modifications and/or simple technical equipment and fittings to the historic building or its immediate context. However, application of the findings of this work is limited to the cases that coincide with the bioclimatic diagnosis expressed in this work and cases where conflict with the environmental conditions is found to be the major reason for deterioration. At the same time, it must carried out in coordination with conventional restoration and preservation specialists. This work is a pioneer attempt for a new perspective for historic preservation and one of the most recent applications of green architecture in today's world.

Conference Topic: The earth/desert/green and sustainable buildings, Integration issues
Keywords: Green architecture, built heritage, restoration, historic preservation.

1. INTRODUCTION: THEORETIC BASE AND FUNDAMENTAL CONCEPTS

The main aim of the concept of greening the built heritage is to ease the conflict between historic buildings and the environment – the conflict that is believed to be the main cause of their deterioration – as an approach for historic preservation. The extents of the problem are variant, according to the quantity and state of historic buildings each nation has, in comparison with its annual expenditure on historic preservation. The term 'greening the built heritage' combines some of the most complicated definitions in the fields of culture and architecture. It is essential to understand each of them separately in order to be able to comprehend their combination.

1.1 Basic definitions about the built heritage

1.1.1 Heritage, built heritage and their relevance to the society

Merriam Webster defines heritage as "something transmitted by or acquired from a predecessor." We inherited that legacy from our ancestors and from nature too. This heritage includes the land that have passed to us, the resources they have discovered or recovered, the way we conduct our daily life and the beliefs or knowledge they have passed to us. When we combine the definition of culture with that of heritage, the term 'cultural heritage' will be the intersection of the two. It is heritage that frames our culture and our history. Historic buildings share a big part of this since they make the envelope for all other activities along with being the building unit of cities.
(Lewis Mumford, 1999)

1.1.2 Green architecture

Green architecture is the response of architectural science to the scarcity of resources, which in general, poses economic, political and social problems. Statistics show that 40% of total energy consumption in the US takes place inside buildings. Thus, green architecture is the art and science of integrating buildings – starting from the construction process – and communities into the ecosystem, in a way that benefits both of them or at least does not harm any of them or cause any additional costs on any of them, in order to create a harmony that guarantees sustainability of investments.

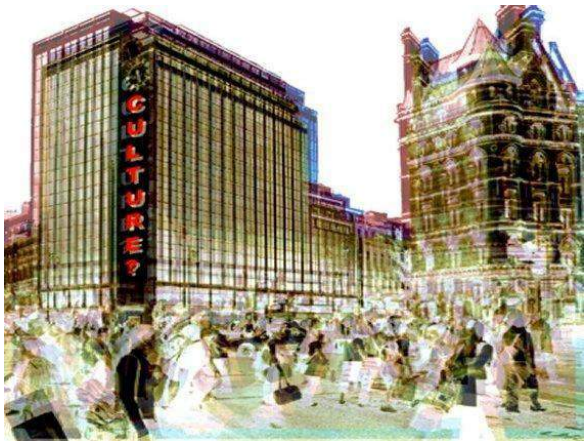

Fig.1: Does the city define culture or is it culture that defines cities? (Source: ErasmusPC focus group)

When we consider choices about conservation and use of the built cultural heritage, within this context, we should consider the specificity of the scarcity of environmental resources, and try to understand the specific trade-offs that it implies. This problem is already discussed in the context of green architecture and hence it is now important to understand the role it can play in the tradeoff between consumption and conservation in the field of heritage.

According to the above definitions, one can comprehend the concept of greening the architectural cultural heritage. It's the process of equipping the historic buildings with the essential tools to be in harmony with nature rather than being in conflict with it.

1.2 The consumption/conservation dilemma

Modern economics has realized and analyzed the tough choice on many levels in different walks of life between consumption of resources in the present and their conservation for future generations to consume. The notion of choice comes from the scarcity of resources in many fields, one of which is cultural heritage. Countries strive to discover, maintain, promote and research about their heritage for this very reason. As a result, there is a continuous process of tradeoffs between current consumption and use, as for tourism, and conservation of that priceless heritage for the future. Therefore, the approach of greening heritage works on easing this economic and administrative conflict by readjusting the built heritage in a way that minimizes the effect of use and wearing out on it, and thus creates a 'smart' membrane between consumption and conservation that allows each of them to operate with a minimum impact on the other.

1.3 Evolution of the concept from current legislations and conventions

It is clear in all conventions and agreements on cultural heritage the necessity to preserve our heritage in a way that makes it accessible and comprehendible today and in the future. This requires slowing down deterioration by the technology and knowledge we have today. For example, the 1972 UNESCO convention on the protection of the world cultural and natural heritage, which by definition includes old architectural works as described in Article 1, states in Part II: National Protection and International Protection of the Cultural and Natural Heritage,

"Article 5:

To ensure that effective and active measures are taken for the protection, conservation and presentation of the cultural and natural heritage situated on its territory, each State Party to this Convention shall endeavor, in so far as possible, and as appropriate for each country:

(a) to adopt a general policy which aims to give the cultural and natural heritage a function in the life of the community and to integrate the protection of that heritage into comprehensive planning programs;

(b) to set up within its territories, where such services do not exist, one or more services for the protection, conservation and presentation of the cultural and natural heritage with an appropriate staff and possessing the means to discharge their functions;

(c) to develop scientific and technical studies and research and to work out such operating methods as will make the State capable of counteracting the dangers that threaten its cultural or natural heritage;

(d) to take the appropriate legal, scientific, technical, administrative and financial measures necessary for the identification, protection, conservation, presentation and rehabilitation of this heritage.**"**

From the previous passage, we can conclude the following points:

1. The importance of the effectiveness of the adopted protection scheme
2. Adopting a policy that guarantees the integrity of heritage into the life of the community.
3. The importance of the presentation, protection, conservation and rehabilitation of heritage to the current generation and transmitting it to the next.

2. GREEN APPROACH TO THE MANAGEMENT OF BUILT HERITAGE:

2.1 Technology issues: Making the environment work for the built heritage

Technological advancements and innovations can help us realize these recommendations discussed in the last section. The energy field has come up with many applications that can be utilized in historic buildings to achieve the goals of this concept, without affecting the character-defining features of the building.

For instance:

1. Solar energy/Photovoltaic panels

Those panels can put in less-visible locations in the historic site in order to generate clean energy for lighting, cooling, heating, maintenance and restoration activities carried out inside the building.

2. Solar heaters

In cases where severe cold weather affects the viability of the historic building and/or its contents, solar heaters can be utilized. They are systems utilizing solar radiation in heating water and circulating water pipes through the walls and underground to provide warmth for the whole building.

3. Solar tubes

They are tubes of internal reflective surfaces that are used to transport natural sunlight into interior spaces far from direct sun exposure. This can save energy and provide better and natural lighting to many spaces inside historic buildings.

4. Energy from tourists' movement: Piezoelectric floors

Already tested in 2008 by East Japan Railway Company in Tokyo railway station, Piezoelectric floors technology can be summarized in putting springs at a certain level beneath the ground that transform the load arising from the weight of the person standing over it into electricity by using springs. Imagine the amount of energy that can be generated at the entrance of a monument like the Eiffel tower in Paris, with 6 million visitors annually. This energy can provide a lot of energy for operating and lighting the monument.

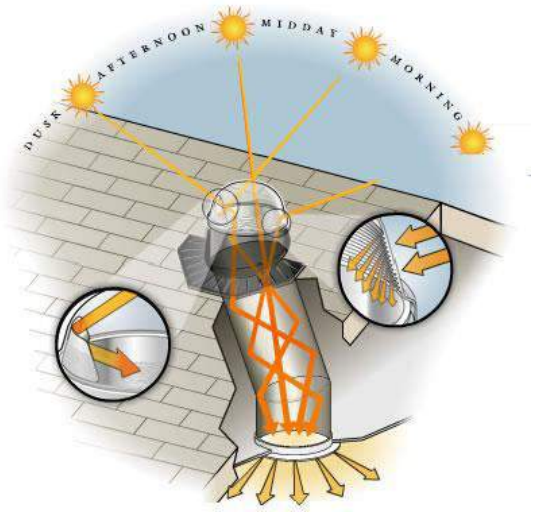

Fig.2: The Solatube® system which captures natural daylight from outside and diffuses it into the unreachable poorly lighted zones. (Photo Copyright: Solatube International, Inc.)

The benefits of this approach are:

1. Decreasing the negative impact of tourist visits to historic sites
2. Providing historic buildings with extra benefits in exchange with the negative impacts they induce over them.
3. Helping making each historic site self-sufficient. This emphasizes decentralization and hence reduces reliance on the central administrative bodies.

2.2 Sustaining the built heritage through natural integration with the environment

In order to sustain our heritage and make sure it is going to be delivered to the next generations, we have to integrate it into its context so that it will not be in conflict with its surrounding environment.

2.2.1 Direct cooling/heating techniques

Direct cooling/heating techniques can be used to decrease the need for any artificial intervention, which is essential in historic buildings. For example, in hot countries the direct cooling techniques will be used most of the year. It has four major components: keeping heat out, providing ventilation, underground construction and evaporative cooling.

2.2.2 Natural ventilation: the cooling fluid for the building's hot engine

If cooling load is still an issue after having controlled as much heat gain as possible, natural and induced ventilation can be used to increase comfort in the face of temperature and humidity levels that would otherwise be uncomfortable for visitors and devastating to the heritage. Natural ventilation is the cooling fluid that goes through the different elements of the environment, at least in hot countries.

This is primarily a function of four variables: air temperature, air movement, humidity and the mean radiant temperature of interior surfaces. Ventilation is considered direct cooling because air movement past the visitors' bodies and walls increases heat transfer from them and because comfort conditions are immediately improved when outdoor air replaces indoor air which is warmed or more humid. It is generally recommended that ventilation rates should be between 200 and 400 feet/min (1 and 2 m/s) to provide comfortable conditions without the assistance of mechanical cooling. Using natural ventilation, historic buildings can be a dynamic part of the environment as well as an open system like everything in nature.

Although weathering results from interaction between historic buildings and the environmental phenomena, but this doesn't mean that all kinds of interaction are harmful. In fact the harmful consequences result from attempting to avoid any interaction, under the name of protection, which causes undesired deterioration since interaction is unavoidable. On the other hand, monuments in harmony with nature have proved to survive.

3. ASSESSMENT AND ENHANCEMENT OF THE ENVIRONMENTAL PERFORMANCE OF BUILT HERITAGE: VIETNAM CASE STUDY

3.1 Influence of Vietnam's climate on built heritage: Hanoi case

Vietnam's climate varies greatly from one area to another due to its large expansion from north to south. The average air temperature reaches the highest values in June and July. In winter, it reaches the lowest value in December and January. Nearly 70% of the time in hot season, the temperature ranges between 24°C and 30°C. Temperatures of 30°C to 38°C only occur in half of that duration.

Hanoi is located near the sea and in the monsoon affected

Fig.3: Vietnam is located on the eastern cost of the Indochinese peninsula and to the south of China. (Source: Magellan)

area and at the same time, there are a lot of ponds and rivers in Hanoi, therefore the RH is very high during most of the year. Relative humidity above 70% takes place almost all the time of the hot season of which, RH of more than 85% occurs in nearly half of that duration. In cold season, the situation is similar.

In summer, the prevailing wind is SE wind, coming from the sea with high humidity. In winter, prevailing wind is N and NE. Passing through the vast continent; the wind becomes dry and cold. It is also usually drizzling in this time that makes the weather worse.

The sun is radiating a lot of heat towards buildings and surfaces, and this heat circulates into the environment. Much of the heat is absorbed by buildings and transferred into interior spaces due to the lack of proper insulation.

Rain fall in Hanoi can reach up to 350mm in the month of August. The heavily rainy season stretches from May to September. During this period, floods may occur and the city is sometimes in a totally paralyzed state due to the lack of proper sewage system. Also for the adequacy of water surfaces created by the heavy rain, underground water levels rise and cause severe damage to buildings and the historic ones in particular.

3.2 Case study: deterioration of Van Mieu Temple, Hanoi

The temple's brochure states that the temple was first constructed in 1070, with much of the architecture dating back to the Lý (1010 – 1225) and Trần (1225 – 1400) Dynasties , but the oldest part remaining now barely dates to the 17th century. The building has been re-constructed, renovated and even the whole site was re-designed numerous times. According to the Vietnamese ministry of culture officials, the lack of documentation of the temple and its architectural and artistic heritage made it impossible to restore the building to its original state and richness in most of the restoration attempts. The renovations done over the last centuries have changed the looks of the site and added elements that changed its character and harmed its integrity. The temple that was the landmark of the city can be hardly seen now, not because of the city expansion, but because of the dense vegetation surrounding it.

Fig.4: Layout of the temple showing dense vegetation and the presence of water surfaces around it. (Source: Google Earth)

3.3 Effects of the climate on the temple

The building, though last renovated in 2001, is deteriorating very fast because of the massive attack of moisture on the building from all directions. The well and water surfaces in the area are leaking into the ground and causing water to attack the building from below. The high humidity content of the air causes condensation on the rather colder surface of building walls. Finally, the heavy precipitation that Hanoi enjoys is providing a lot of water on the building's roof. Moreover, the lack of air

movement is making things worse by preventing proper evaporation of excess moisture.
Those conditions combined with human factors, such as soil, air or water pollution caused serious complications on historic buildings including:

1. Structural failure

Long-term attack of underground water to historic buildings foundations all can cause structural failure. This can lead to major deterioration like cracking and failure of some of the building's structural elements like columns, bearing walls and roofs.

2. Damage of surfaces

High humidity levels, water and salts can cause major deterioration for building surfaces and walls that hold significant historic testimonies. Acid rain in particular is one of the most destructive factors leading to decay of surfaces. The principal cause of acid rain is sulfur and nitrogen compounds from human sources, such as electric generators, factories, and motor vehicles. Acid rain causes damage to certain building materials and historical monuments such as stone, brick and metals. This results when the sulfuric acid in the rain chemically reacts with the calcium compounds in the stones (limestone, sandstone, marble and granite) to create gypsum, which then flakes off.

Fig.5: Mould growth and deterioration of the temple. (Source: Author)

$CaCO_3$ (s) + H_2SO_4 (aq) → $CaSO_4$ (aq) + CO_2 (g) + H_2O (l) (Source: epa.gov)

3. Change of colors and/or composition

The different environmental factors can combine to cause change of colors and/or composition of the features of historic buildings. This is mainly accounted to pollutants suspended in the air and that can find shelter in porous brick and stone materials, leading to chemical reactions that can be accelerated with the presence of heat and humidity.

4. Deterioration of collections

Collections stored in historic buildings, furniture, decorative elements and artistic works are significantly affected by environmental factors. Pigments and paints are vulnerable chemical substances that can react negatively to weathering.

5. Accumulation of dirt or mould

Encouraged by humidity and rainwater, lack of ventilation and sunlight, mould and fungi find shelter in stone surfaces of historic buildings in tropic and European countries. They massively attack stones and bricks, and cause cracking, and decomposition.

Fig.6: Cracks resulting from failure of newly built walls. (Source: Author)

Fig.7: Peeling of paint in walls renovated in 2001 due to the high humidity levels. (Source: Author)

3.4 Greening Van Mieu Temple

3.4.1 Assessment of Hanoi's environmental profile

The chart in Fig.8 combines temperature and relative humidity data and compares them with basic standards for green buildings in order to specify the recommendations to make them energy-efficient and comfortable for their users.

Six months lie in DH (Dehumidification zone), one in V (Ventilation zone), three in IG (Internal Gains zone), one in INV (High Inertia and Night Ventilation zone) and only one in C (Comfort zone).

This shows the complexity of the climatic profile of Hanoi, and stresses on the importance of adequate ventilation and dehumidification around most of the year.

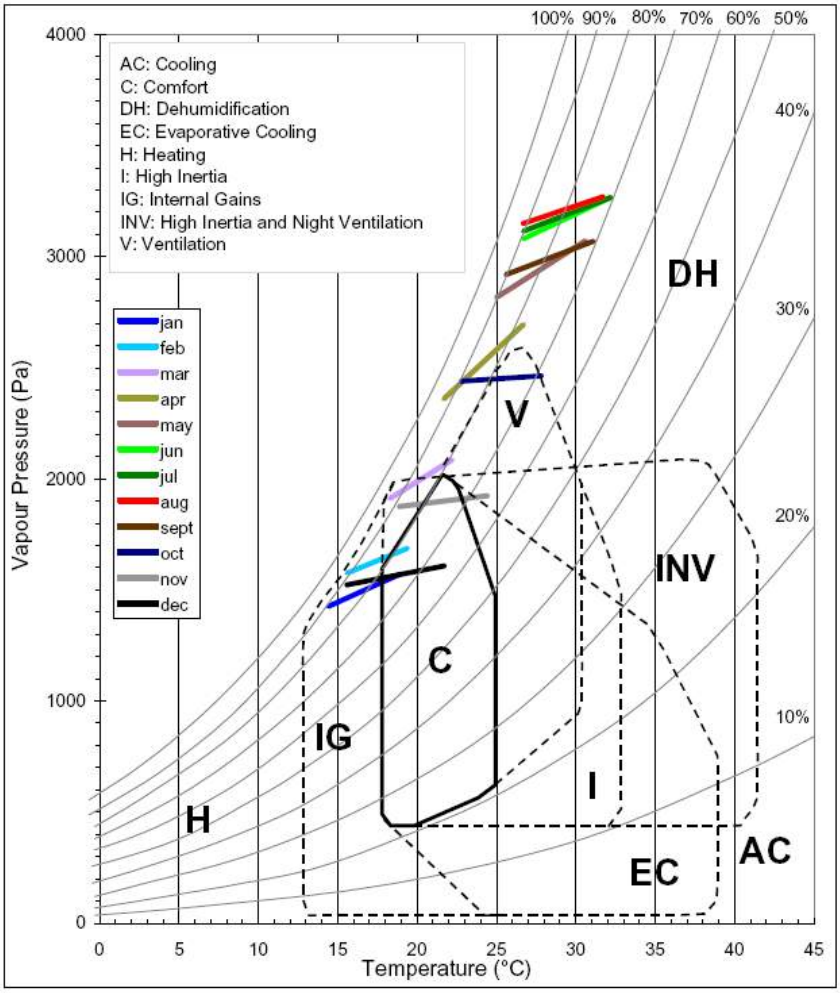

Fig.8: Givoni's chart for Hanoi (Source: Nguyen Quang Phuong, Vietnamese National Institute of Architectural Research)

3.4.2 Assessment of the Temple's environmental performance

1. Turbulent flow of wind

Due to the massive existence of big trees all over the site, the flow of wind is being diffused and chattered in a fashion that stills air flow and causes higher humidity and discomfort levels.

2. High humidity and moisture levels

With the well and four artificial water surfaces, plus the nearby lake like everywhere in Hanoi, the humidity levels are just too high for survival of such a fragile heritage

3. Division of site by walls

The division of the site into five yards causes the site to even perform worse, by further barring air movement and sight through the temple's site.

4. Zero air movement and highest humidity inside the main temple building

With openings from only one side and with the already barred wind in the immediate context of the temple, air movement inside the main temple is recorded at 0 m/s and a high relative

humidity of 73% although the levels recorded around the temple immediately were 68% and 69% respectively. This is devastating for the building and its users' health. Mould is growing allover the place especially with the frequent heavy rain.

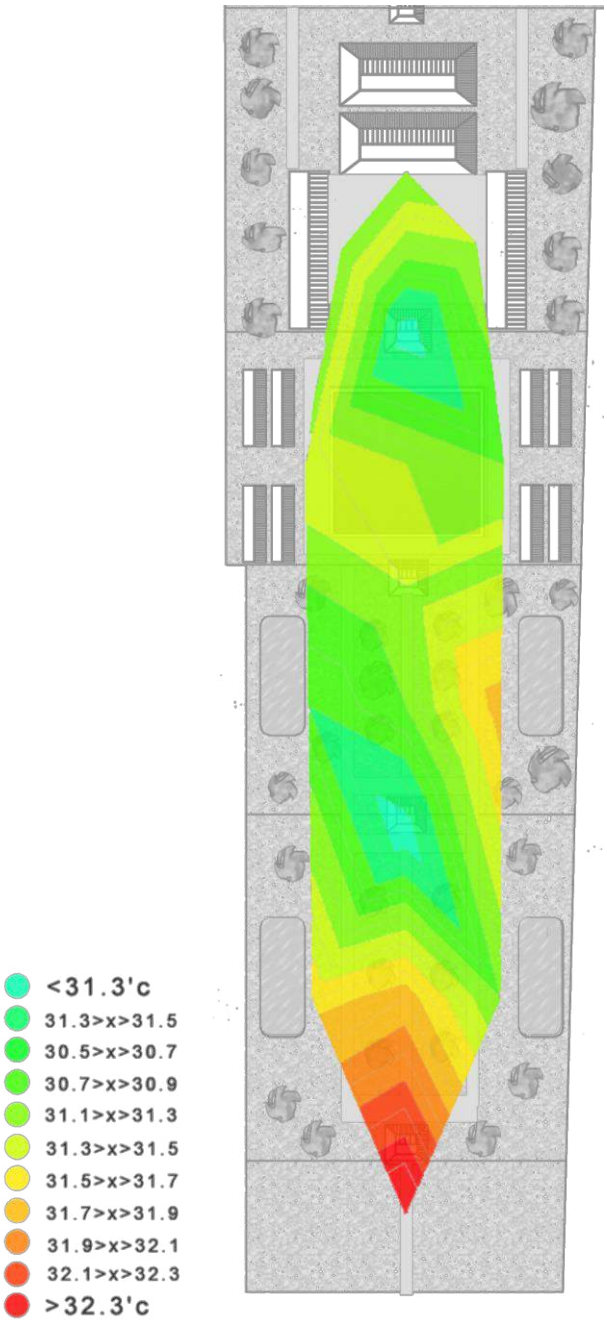

Fig.9: A schematic diagram for the flow of heat in on the site of the temple, which is a fundamental factor in the analysis. (Source: Author)

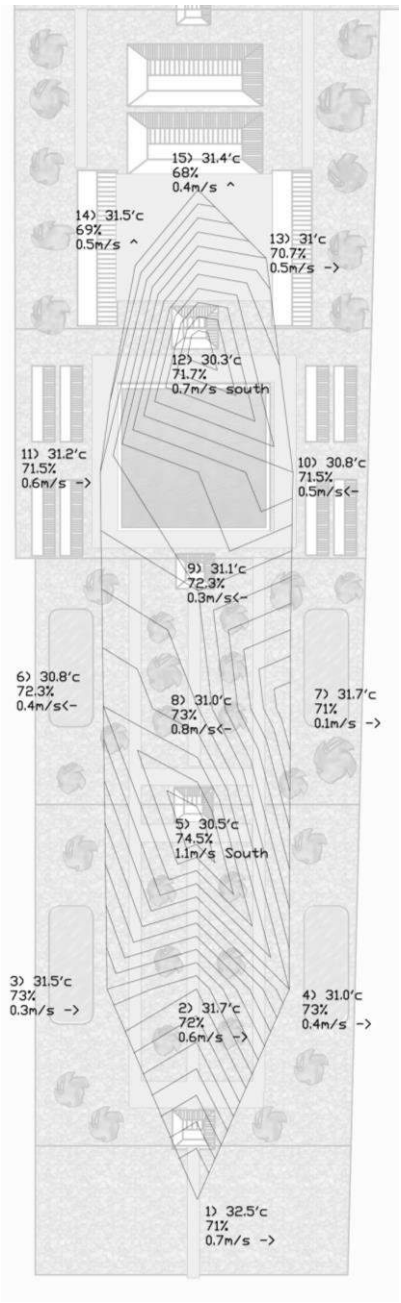

Fig.10: Readings of temperature, relative humidity and wind speed and direction at selected points, on a contour-line diagram. (Source: Author)

3.4.3 Recommendations

To solve the current situation and minimize preservation expenses, together with maintaining the priceless cultural value of Van Mieu Temple, the following recommendations should be considered:

3.4.3.1 On the level of context

1. Decreasing dense vegetation around the building, since it causes high humidity levels, and replacing them with light well-designed vegetation, in order to create shade and directing wind into the desired spots without reducing their speed.
2. Creating green buffer zone only between water surface and the temple against the direction of the prevailing winds (Fig.11)
3. Creating shades over water surfaces to decrease evaporation.
4. Providing good insulation underneath the building to protect it from underground water.
5. The use of waterproof oil paintings instead of plastic paints.
6. The use of water-treated cement in any renovation processes in the future.

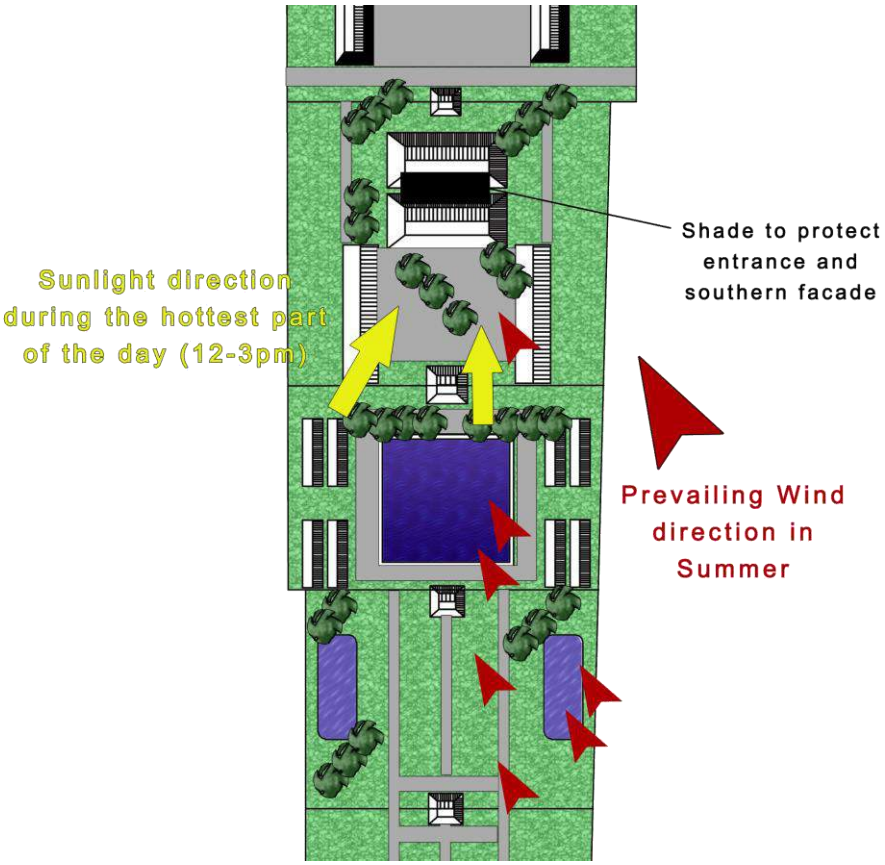

Fig.11: Suggested re-design for the layout of the temple in order to solve humidity, air movement and temperature problems. (Source: Author)

7. The study of using solar chimneys to increase air movement in the main temple, instead of the big fans currently used.
8. Opening up apertures in the walls which divide the site. These apertures already exist in some walls and should be imitated in the rest of them, to allow more air movement and site into the site.

3.4.3.2 On the level of the main temple enhancement

With openings from one side only, the building can never be ventilated properly. The ancient builders of the temple have taken that into consideration, but with no documentation of that, the temple was never re-built in an environmentally-aware way. The introduction of two openings in the direction opposite to that of the wind should create a wind speed of at least 3.0 m/s instead of the current 0.0 m/s. The openings should be architecturally and aesthetically integrated into the building's design, in order not to change any of the cultural aspects of the building.

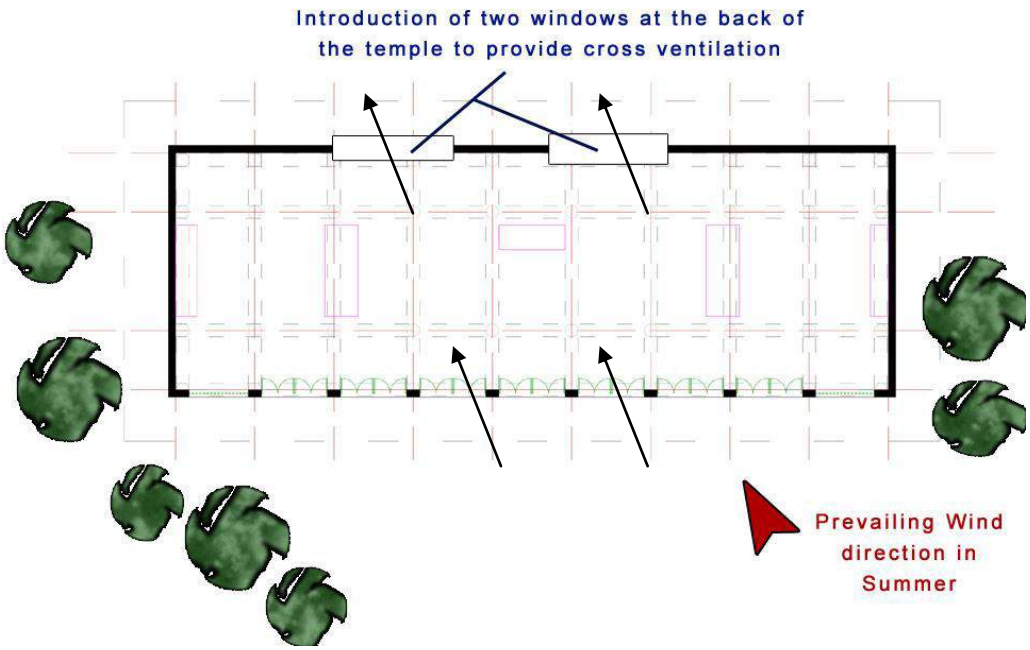

Fig.12: Suggested introduction of two windows at the back of the temple, which are not going to be visible, since they are behind the focal point of the temple; the statues of Confucius and his apostles. (Source: Author)

4. ECONOMIC IMPACT AND EFFECT ON RESTORATION EXPENSES

4.1 Lifting the supply curve to cope with the increasing demand

Lifting the collective nation-wide cultural supply curve from the point of view of the approach exhibited in this work is possible through integration of heritage into its environment, both the human and the natural. The integration of heritage into the human environment means putting it in an important role in peoples' lives. This can be achieved by using the heritage, primarily in its original use or, if the state of the building allows it, reusing it in a way that makes it an active contributor to the national cultural identity. In this way, heritage can provide the market with competitive supply of cultural products that can cope with the increasing demand.

4.2 Sustaining the built cultural capital

The economic importance of keeping our capital of historic buildings is huge. Most of today's most visited destinations in the world are historic buildings. They bring huge investments into their neighborhoods and cities, while bringing huge revenue for the tourism industry. Single historic buildings hold distinctive positions in the list and in some cases outnumber the number of visitors to entire countries. For example, the Notre Dame de Paris receives 12 million visitors yearly, which is slightly more than the visitors of Egypt in the same period. Greening the built heritage will guarantee the continuation of the role it plays as a cultural and economic capital for nations.

4.3 Effects on heritage value and restoration expenses

Adopting the GACH approach can decrease preservation and/or restoration expenses significantly by decreasing their occurrence and intensity, while at the same time protecting the overall value of the built heritage.

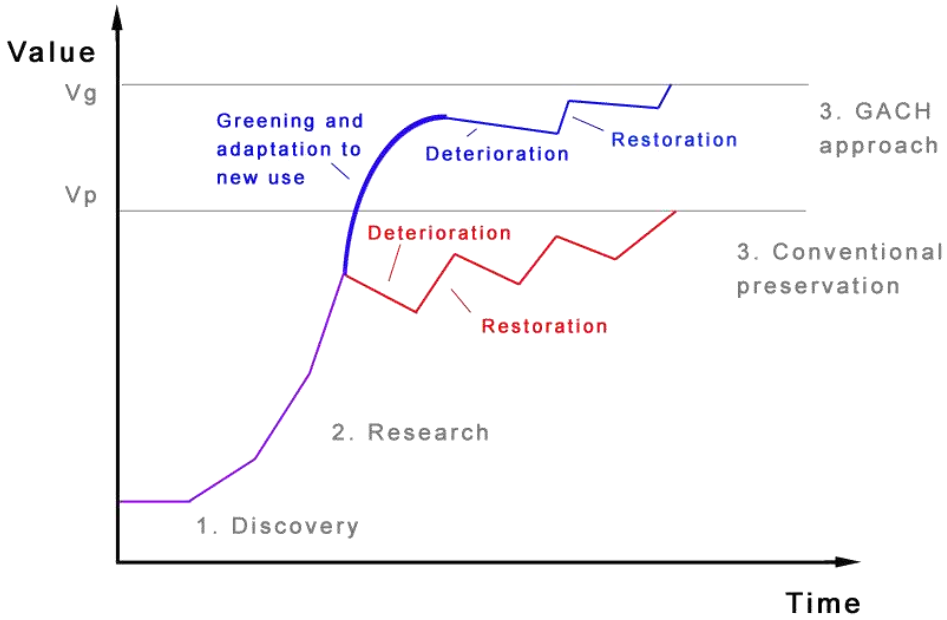

Fig.13: The expected effect of applying the GACH approach on the value cycle of heritage and restoration efforts. (Source: Author)

The saved money may vary from one case to another according to the severity of the conditions and environmental factors that the site faces, but there is no doubt that at least some money will be saved.

As Fig.13 shows, conventional preservation schemes fail to protect heritage from what they call "traditional wearing out", and therefore allows concurrent deterioration and costly restoration procedures. While the greening and adaptation phase the approach recommends can significantly enhance its ability to defy deterioration, and hence creates the value enhancement which reflects on the supply curve of the cultural product provided by the heritage. This, in return, enables heritage to transfer the message it holds in a better way, and at the same time stimulate the economic cycle behind it.

5. CONCLUSION

5.1 Overview

According to the outcomes of this study, it is clear that greening the built heritage is a necessity for many of them, in order to sustain their presence and their ability to perform their cultural role in the societies. Greening heritage is part of human effort to make efficient the different aspects of life, in a world that is striving for sustainable solutions.

5.2 The continuity of the approach

5.2.1 Pilot projects and generalisability

Since the approach is a new one, pilot projects must be made – after making the necessary case-specific cost-benefit studies − in order to analyze the outcomes of this approach in real time and measure its success in different contexts. If the outcomes prove to be promising, in a

satisfactory percentage of the pilot projects, preparations should be made to start spread knowledge about the new approach. However, the implementation of the approach in cases different from the one discussed requires case-specific studies on contextual/environmental factors and the status of the historic building involved in that case.

5.2.2 Educating about green preservation: Preparing a generation of green preservationists

Most of the preservation community and specialists come from backgrounds like history, management, engineering, archaeology and restoration. Moreover, the architects involved in the process, have little knowledge about green architecture, let alone the new field of green preservation. Therefore, green architecture specialists and green architects concerned with historic preservation should introduce more education about the environmental preservation approach as training to young preservationists and restorers.

5.2.3 Fitting the approach in the administrative systems

In most countries, the process of preservation is usually taken care of by ministries of culture or one of their subsidiary departments, councils or commissions. In countries with federal systems, local governments of counties or provinces hold the responsibility of carrying out the planned projects and in many cases prepare the preservation plans and only submit them to higher authorities for approval. This knowledge of the administrative system for a given country is crucial to know where to introduce the approach of greening heritage in the system. Generally the approach must be integrated on three main levels; planning, implementation and then follow up. Therefore, the administrative bodies carrying out each step must include an advisor or a specialist in green preservation techniques in order to make sure that all preservation/restoration policies and plans conform to green preservation requirements.

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