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Mediterranean Green Buildings & Renewable Energy

Selected Papers from the World
Renewable Energy Network's Med Green
Forum



 Springer

Sustainable strategies for protecting and managing the cultural heritages. The case study of Gonfienti in Tuscany.

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Keywords: Archaeological spaces, sustainability, protection, rehabilitation, accessibility, shading devices, renewable energies

ABSTRACT

Global warming has caused a sea level rise never noticed in the past as well as increasing storm intensity. Both phenomena are responsible for an increase of flooding and erosion of many archaeological remains located on the coast, which constitute a weak interface between hydrosphere, atmosphere, anthroposphere and lithosphere. The research project aims to develop a sustainable model for safeguarding the archaeological sites from the adverse effects of climate change and deterioration. In addition, by site-specific planning and design, based on ecological, bioclimatic and energy efficient strategies and techniques, sustainable preservation and enhancement of the cultural heritage is to be achieved, in order to increase sightings and accessibility.

The main objectives of the project are:

- Investigating the impact and damage inflicted on the archaeological sites by the climate change and the risks and hazards of further deterioration.
- Analyzing the local climatic conditions and evaluating and utilizing the free energy systems available on the archaeological sites and at the same time respecting the cultural character of the places.
- Improving the visitors' experience by creating a pleasant and comfortable sightseeing environment.
- Rehabilitating the selected archaeological sites in a holistic approach by protecting, defining and upgrading the sites through advanced planning and design solutions.

The project will establish a comprehensive state of the art of the archaeological sites and spaces in the Mediterranean regions. It will select three pilot site-studies, one in each participant country -Italy, Cyprus and France- to ultimately conclude to the sustainable preservation and cultural enhancement of the archaeological sites for high societal benefits.

Introduction

The preservation of the cultural heritage is strongly linked to the study, safeguarding and evaluation of the barriers, the risks and vulnerabilities concerning the sustainability of the archaeological sites and spaces. The rich cultural heritage of countries is under threat also due to the effects of climate change, the adverse climatic conditions and especially the impact of extreme weather events that have on the historic and archaeological places also on the tourism aspects. For preserving archaeological heritage an efficient, long-term management is needed to protect, enhance and revitalize the cultural places for future generations. Moreover, a sustainable approach to a sustainable tourism of Archeological sites will encourage a most structured and managed tourism with economic benefits for all the associations responsible of the site management; the planning of sustainable transport in the archeological sites, the integration of existing technological renewable components on temporary info-point, usage of renewable energies for dedicated information of the site on screens will be adequately investigated.

The project will endeavor to surface the underlining principles, which shaped the archaeological sites. Exploiting local resources, responding to local climate, vegetation and topography and guided by local cultural traditions where the wise tools used by the ancients to attain and build over the ages a precious harmony

between the structures and the setting. These are the very tools to be used in this project to protect ecologies that took millions of years of evolutions, as well as the richly ordered human historic constructions that took thousands of years of sensitive accretion. In this way, this project will aim to contribute to the birth of a viable European civilization, cherished by the tourists, in which networks of communication and trade will no longer just be homogenizing and distractive agents. In contrary, this will have such abundant capacity as to allow local and regional particularities, inherent in the historic sites, to survive and be savored enhancing the specifics of culture, climate and topography.

The project will emphasize the significance of archaeological sites to help communities remember, as well as the role we have in helping preserve, forgotten pasts and promote sustainable heritage tourism. The project aims to redefine selected pilot archaeological sites in three Mediterranean countries: Italy, Cyprus and France; it also aims to identify the most appropriate planning and designs based on ecological, bioclimatic and energy efficient design strategies and techniques, to achieve sustainable preservation and enhancement of the cultural heritage, in order to increase sightings and accessibility. The tourism industry shows a great potential benefit resulting of the proposed transition. It will be based on a holistic, regional approach and will aim to combine the instrumental values of civilization with the human concerns of heritage and local culture.

Three main goals have been defined:

- Creation of a potentially threatened sites corpus. Towards their social integration, environmental adaptation and economic development
- Creation of a protocol study for preventive intervention if no material or other means, of protection could be applied.

Creation of documents to :

- Orientate the national archaeological scheduling to make the study of coastal sites or any others under threat of climate change etc, one of the priority issues.
- Encourage the organisations in charge of the general, as well coastal administration to implement concerted programs for sites protection, with adapted means for each situation.
- To increase awareness amongst decision-makers in the Mediterranean countries of these issues.

Objectives

A significant aspect of the project is to establish national advisory committees, a collaborative network amongst relevant scientific centers, professional associations and public and privates bodies, seeking effective dissemination to ensure engagement by socio economic communities.

Shortly, the research project objectives are based on:

- The investigation of the impact of climate change on the archaeological sites and on related tourism management proposing guidelines for the mitigation of its' effects.
- The most appropriate utilization of the climatic damaging factors that provoke the deterioration of the site, using for example the direct solar radiation in a productive way, annulling and inverting their effect (eg. renewable energy production systems on tents, such as PV panels; solar screening with green, water collection systems, wind power, geothermic etc), specially the clean rain water collection is needed by the archaeologists to clean the findings.
- Create pleasant sightseeing environment for the visitors, by improving their comfort level during their touring and stay in the place and usage of the interactive local info-point on the archeological site connected to their renewable energy structure (i.e. photovoltaic umbrella, creative use of water, sustainable mobility into the site, pleasant seating along the walking way, etc.)
- Analyze the potential of the proposed tools and solutions in the context of archaeological sites management practices.

Methodology

Protection of archaeological sites requires an aggressive long-term management programme that includes thorough documentation of site characteristics and conditions, stabilization, security, maintenance, monitoring, compatibility and research. Employing analysis techniques to define the context of the problems that the archaeological heritage of each participant country is facing (risks, hazards, damaging and deteriorating factors etc).

For this reason, information obtained using both satellite and ground remote sensing techniques will be implemented into a Geographical Information System (GIS) in order to investigate the impact of climate



Fig. 1 Gonfienti archeological site near Prato, Italy

change and destructive agents of the sites. The use of archive satellite dataset along with in situ observations using sun-photometers and LiDar technology will assist to the better the understanding of the impact of these agents to CH monuments. The integration of the above state of the art technologies will lead to the production of climate change vulnerability maps for each participating country. In addition Global Position Systems as well archive stereo-pairs aerial images will be used in order to reconstruct the historic landscapes for the last century. Three archeological sites are chosen, one per each country, as pilot cases; the local resources, climatic conditions and the beneficial aspects of the archeological sites will be used in order to evaluate and enhance the special character of each archeological site. We specifically described the strategies we intend to adopt for the Italian archeological site, Gonfienti near Prato and Florence. Advanced design techniques, including the implementation of a renewable energy production system in combination with the

application of local ecological materials that will be linked to the surrounding landscape and the specific constructions made to protect the place and the visitors, are proposed in order to protect the archaeological landscapes from the impacts of climate change. Especially, for the protection of these places from extreme weather events such as extreme rainfall, extreme temperatures, extreme wind speeds and extreme natural phenomena such as earthquakes, volcano explosions ect. These strategies are the core to be used to formulate the plans and designs oriented to preserve and adapt to the climate change the archeological sites. Comparative evaluation studies are carry out of relevant strategies applied in other Mediterranean region Archaeological sites.

The planning and designing of the spaces, for the ecological preservation and enhancement of each pilot archaeological site.

Schematic designs are formulated for each selected historic location, using adequate software for simulations, in order to protect the archeological sites from damage and deterioration and at the same time acknowledge and respect the symbolisms and elaborate, savor and intensify the local particularities of the site. An in-depth analysis of the possible alternatives presented to include production of renewable energy on site will be considered so that the archaeological places could be self-sufficient, or even contribute to the energy needs of the region, without altering the character of the site.

The designs will be also oriented to the comfort of the visitors – tourists. The improvement of the way people experience the site (accessibility, comfort during the visit etc) is indispensable in order to reevaluate the space and increase the visiting rate.

Urban, Territorial and Landscape designs, including small structures, will be developed to exploit and enhance local topography and climate, just as the archaeological site and constructions did and with a similar sharpening of the regional flavor. The designs will aim at achieving variety, continuity and coherence by making connections with and enhancing the specifics of culture, climate and location in sensitive, disciplined yet willful acts and imaginative designs. Comparative evaluation studies will be carried out of relevant designs applied in other Mediterranean region Archaeological sites.

The archeological site of Gonfienti (PO) in Tuscany, Italy

The Etruscan population to which Tuscany is closely tied is mysterious in many ways starting from its name: the area between the Arno and the Tevere rivers in the pre-Roman period belonged to the Etruscans or Tuschi. In that period their name was Etruria or Tuscia. Subsequently from Tuscia the name became Tuscany. A disastrous famine drove them here from the middle East in the first millennium B.C. This population was already fortified by commerce, used to traveling by sea, had a strong army, even without the trace of a prince or a leader.

The structure of their society was based on the form of a clan, organized in *luchums*. No more than twelve in the whole of Italy. When the settlement was consolidated, this was rigorously the number of federate state-cities, to form a powerful economical, religious and military alliance: the Etruscan League. The following important cities of modern Tuscany were part of it: Roselle, Vetulonia, Populonia, Arezzo and Volterra, then Cortona and Fiesole. The oldest one has walls surrounding the city, built during the time of danger, square plans with decumanus doors.

The last discovery destined to mark a turning point in history in the study of the Etruscans is dated 1996. A big Etruscan acropolis dating back from the VI-V^o century B.C. came to light by chance in the eastern outskirts of Prato (In the area of Gonfienti). In this area, at the edge of the plain of Prato, under the Apennine, along the 'Sole' motorway that today connects the north of Italy with the south the Etruscans settled thousands of years ago. After archeological analysis Gonfienti appeared as one of the greatest acropolis that has been discovered up to now, connected to its sister city the Ancient Misa (currently known as Marzabotto, in the region of Bologna). For the last two hundred years it has been an important trade centre of Etruria and some experts even believe that it may have been the mythical city where King Porsenna was buried. The religious statue in bronze of exquisite beauty called "l'offerente" (now at the British Museum of London) discovered in 1735 less than one kilometer away from the settlement was not found there just by chance, the site is not yet open to the public.



Fig. 2 View of the Gonfienti area

Ventilation strategies for membrane roof should be adopted, the design solutions to protect the Gonfienti area developed use the following systems:

- Photovoltaic roof, open air with semi transparent panels
- Translucent materials EFTE membrane
- PTFE Glass
- PVC/PES

- Tensotherm
- TO2

To protect the archeological site we have chosen different light roofs, one of this is a fabric roof membrane. It has the advantage of being light in weight, strong in tension and durable, and has the ability to be cut to different shapes and joined together economically. Roof membrane fabrics used tension structures, either by stretching the material, or ‘prestressing’ the membrane, between structural supports or, alternatively, by supporting the material pneumatically in inflated structures. The use of fabric membranes in prestressed roofs seems to be a technology very usefull for the most common application of inflatable fabric roofs.



Fig. 3,4,5,6 Efte example of membrane, the air-tight cushion offers shelter while bringing light through its transparent form - photo by Niklaus Spoerri



Fig.7 Efte semitransparent roof

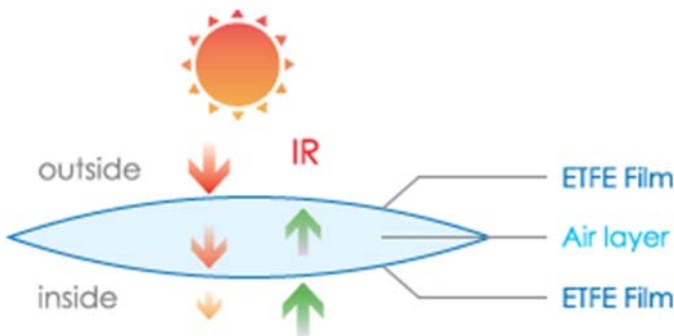


Fig.8 Section of half EFTE menbrane

Another system taken into account to placed above the archeological site, is a semitransparent roof made by: a transparent part composed by ETFE cushions so as to optimize the lightness of the support structure. Each cushion is made with white and transparent ETFE panels staggered to create shadow effects and to reduce the solar factor.



Fig. 9 This cover is realized in a stretchable water tight fabric insures an easy protection against sun and rain. The stretchable fabric

bends and strains under tension. It is ultra light (only 3kg) and easily washable. The corner fixation hooks get automatically loose in case of strong gusts or excessive tension.

Fig.10 Fully transparent, and open in the central part to maximize natural ventilation of the site

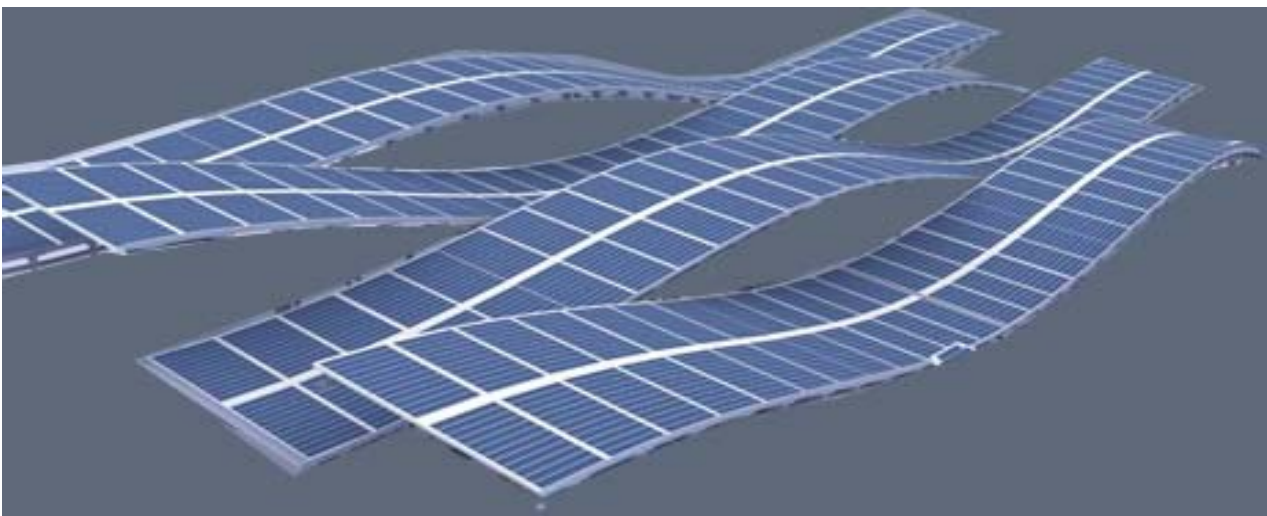


Fig. 11 Roof integrated BIPV allow the entry of natural light, provide both thermal and sound insulation, filter out harmful radiation, produce clean free energy.

The environmentally sensitive design include tourism facilities built in the archeological architecture, in the following ways:



- *Rainwater catchment:* Rainwater is collected from the roof in the rainy season, passed through a natural filter, and stored in underground cisterns h to be reused in the green areas.
- *Solar water heating:* Rainwater is pumped up from cisterns through a solar powered eating system into hot and cold-water containers for the toilets and showers.

Fig. 12 Another solution for the PV shelter roof

- *Greywater recycling:* Water from showers is recycled through plant beds so that no polluted water seeps into the area. Beds are planted with species with high water and nutrient requirements, appropriate for the shower water rich in nitrates and phosphates.
- *Natural ventilation:* The roof have natural ventilation, from the topo and both sides.
- *Composting toilets:* Toilets economise on water. They also prevent sewage seeping through the porous ground into the area. The human waste quickly decomposes to natural fertiliser when mixed with compost (aerobiccomposting) in the compost chamber.

- *Photovoltaic power*: Lights are powered by photovoltaic panels on the roof, which provide enough energy for average use.



Fig. 13, Fig.14, Fig. 15 Different solutions of translucent Photovoltaic roof and with pv shelter



Results

The project through a web site is creating a national advisory committees in order to guarantee a permanent exchange of information, research results, development of technological solutions, experiences and dissemination of results, applied incentive schemes and governance models of adapted transition.

Implement the collaboration with other European and Universal bodies as UIA-ARES (International Union of Architects – Architecture and Renewable Energy Sources).

The principal goal is to share the experience in the field of archaeological heritage preservation in European countries.

The milestones focus on:

- Provide legal framework and National Strategies for preserving the archaeological heritage.
- Understanding the meanings that cultural heritage holds for people and how they perceive, use and interpret it.
- Developing an archaeological heritage management and sustainable development system.
- Investigating the climate change impact and the possible mitigation measures concerning the archaeological places.
- Developing methodological tools and designs for ‘integrated landscapes’.
- Promote cultural tourism and archaeological heritage preservation.
- Increase accessibility and visiting traffic and frequency in archaeological sites.

The project is generating new, research-based knowledge to promote the sustainable use of cultural heritage in order to meet societal challenges and contribute to the development on the local, national and international societies.



Fig. 16 One of the analysed solution for the Gongienti archaeological site with a PV roof

Conclusions

The project reach a significant impact due to the nature of the project itself and due to the expertise of the consortium; moreover, it is due to the type of the chosen heritage archaeological sites.

The ideas and knowledge, which will be transferred to the public and private sector, will include the main aims and most significant results of the project:

- The proposal is aiming to redefine the notion of what an archeological site can mean to the society. The imminent risk of destruction of important cultural heritage sites should be prevented. This can be achieved by a holistic design that permits the adoption of new techniques and technologies.
- Through this study new and innovative ways of dealing with the protection of an archaeological site will be listed in guidelines that can be used by all archeological sites in Europe and abroad.
- The public and private sector can benefit from the outputs of the research in a positive way, given the utilization of the sites as power-producing spots. The interest for investments aiming to the protection of the place would increase, thus helping the protection of the sites..
- An interactive relation between the local people, the visitors and the staff will be promoted by the use of questionnaires giving their perception, before and after the rehabilitation.

The outline plans for dissemination aims to increase synergies amongst researchers and non-academic stakeholders, including SMEs, heritage owners, public administrations, research partners and local communities. The tasks will include the development of information material (logo, website, videos, images etc.), as well as inputs to European portals and databases in the quality and form specified. Dissemination events such as workshops, conferences, briefing days, exhibitions will also take place during the project duration. Moreover national advisory committees will developed, in order to guarantee, a permanent exchange of information, results, technological solutions and experiences.

The sustainable tourism as an approach for the archeological sites is a new vision and the new idea of this project and the impact will increase financially the subsistence of the site itself.

Consequently results of the projects will be of high value not just for researchers but also for non-academic stakeholders, including SMEs, heritage owners, public administrations and local communities.

Acknowledgement

We thanks contributions of the research team leader ABITA Interuniversity Research Centre (DIDA Dept. University of Florence Italy), ABITA is a large Interuniversity Research Centre focused on sustainable issues in Architectural Technology and Environmental Design, CUT Cyprus University of Technology.

The Cyprus University of Technology has as its strategic target the design and development of research activities both within the University and in cooperation with other research Institutes in Cyprus and abroad.

The Cyprus Institute (CYI, www.cyi.ac.cy) is a non-profit, technology-oriented, interdisciplinary research and educational institution aiming at world-class standards of excellence. The Laboratoire d'Archéologie Médiévale et Moderne en Méditerranée.

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