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SCIENZE E MATERIALI DEL PATRIMONIO CULTURALE

**CULTURAL HERITAGE  
FACING CLIMATE CHANGE:  
EXPERIENCES AND IDEAS  
FOR RESILIENCE AND ADAPTATION**

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# Natural Disasters and Risks in World Heritage Monuments of Greece. Lessons Learnt

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**Abstract:** Risks from natural disasters always have been a major concern because they can cause extensive damage to World Natural and Cultural Heritage. This is particularly so today because many natural disasters are brought about, or increased, by climate change throughout the world.

Reducing and managing the risk of man-made and natural disasters are major challenges that the world community is facing. Disasters are the consequences of uncontrolled human activity and poor environmental management, bringing damage to World Heritage monuments which are inevitably exposed to these dangers.

The international organizations such as UNESCO, ICOMOS, IUCN, ICOM and others, have adopted principles and strategies for the management of risk reduction, which should be applied to every site or monument while training should be provided for the personnel in charge.

**Résumé:** Les risques liés aux désastres naturels ont toujours été une préoccupation majeure car ils causent des dommages importants au Patrimoine mondial naturel et culturel. C'est particulièrement le cas aujourd'hui car de nombreux désastres naturels se produisent ou sont intensifiés par le changement climatique mondial.

Réduire et gérer les risques anthropiques et les désastres naturels sont des défis majeurs de la communauté scientifique. Les désastres sont les conséquences d'une activité humaine incontrôlée et d'une pauvre gestion de l'environnement, entraînant des dommages aux monuments du Patrimoine mondial, inévitablement exposés à ces dangers.

Les organisations internationales telles que l'UNESCO, l'ICOMOS, l'IUCN, l'ICOM et d'autres, ont adopté des principes et des stratégies pour la réduction des risques, qui devraient être appliqués à chaque site, tandis que la formation des personnels concernés devrait être organisée.

**Keywords:** natural disasters risks, Olympia protocol, managing, cultural and natural heritage, disaster risk reduction and mitigation.

**Mots clés:** risques de désastres naturels, protocole d'Olympia, gestion, patrimoine culturel et naturel, réduction des risques de désastre et atténuation.

Risks from natural disasters have always been a major concern, because they can cause extensive damage to World Natural and Cultural Heritage. This is particularly so today, because many natural disasters are brought about, or increased, by climate change throughout the world.

Reducing and managing the risk of man-made and natural disasters are major challenges that the world community has to face. Disasters are the consequences of uncontrolled human activity and poor environmental management, which provoke damage especially to important World Heritage monuments which are inevitably exposed to these dangers.

In Greece it is well known that in 2007 devastating forest fires occurred in the area of **Ancient Olympia** (fig. 1). Fires are definitely

increased due to rise of temperature. These extensive fires burned more than 150,000 ha in forest and agricultural land in five days (Kanefusa, 2009). However, this brought about new studies on proper vegetation selection and more advanced ones for fire extinguishing mechanisms.

The fire in Olympia certainly is not the only case of extreme weather conditions affecting the natural and cultural environment in Greece. The story of the flood of Deucalion is one of the best known of ancient Greek myths, one of the world's many flood myths. It is based on the real occurrence in the distant past of torrential rains causing catastrophic damage to human life in the Mediterranean basin and the Mesopotamian valley.

The catastrophic results of extreme natural events are recorded not only in myth, but also



1.- Archaeological site of Ancient Olympia, Kronios Hill before the fire of 2007.

*Le site archéologique de l'Ancienne Olympie, Mont Kronios, avant l'incendie de 2007.*

appear at various times based on the archeological data. The volcanic explosion on Thera in the 16th c. B.C. and the destruction by earthquake of the ancient city of Helike in the northern Peloponnese in 373 B.C. (Katsonopoulou, 1991) are the two most extensive known disasters in ancient Greece.

Humans, of course, cannot rule nature. We can, however, limit the consequences, that disastrous natural events have upon us and the natural and human environment (Stovel, 1998). Certain cases of risk mitigation are presented here concerning Greek World Heritage monuments, from which certain general conclusions can be drawn.

One example of professional efforts to prevent problems caused by extreme natural events is the steps taken by the Greek Archaeological Service today in the area of the famous site of **Delphi** (fig. 2), which has been on the list of World Heritage Sites since 1987 (Partida, 2009). Delphi is located on the steep slopes of Mt. Parnassos in a beautiful, inspiring setting. The archeological site's relationship with nature has been inseparable in myth and throughout history. We know from ancient sources (Gruben, 2000) that the site suffered from rock falls in Antiquity, and it continues to do so today. Recent heavy rains and the effects of great variations in temperature due to climate change in the cliffs have again raised the issue of protecting the archaeological site of Delphi from falling rock. After closely examining the area, several rock securing projects have been implemented and rock fall protection

systems have been put in place so far in certain locations of the site, aiming at the protection of the monuments beneath the cliffs.

In order to deal with the problem on a more permanent basis, collaboration has been established between the Ministries of Culture and Sports and of Infrastructure, Transport and Networks, the latter being involved, since a branch of the national road passes through the area in question and thus is also endangered by the rock falling incidents. Under this perspective, a multi-disciplinary disaster risk management plan is under way, which elaborates on various and alternative solutions in order to protect both the archaeological site and the road. The proposed measures include, among others, the construction of strong retaining walls, as well as of ditches and barriers in successive rows for the containment of the falling rocks, the placing of a warning system, that blocks a specific area in case of rock falling, the anchored reinforcement of the rocky formations, the construction of protective shelters for certain visitors' paths without allowing these protective structures to interfere and to harm the beauty of the site.

**The Medieval City of Rhodes**, inscribed in the UNESCO World Heritage List in 1988, was threatened by a complex combination of natural decay factors (marine atmosphere, salt decay, rising humidity) man-induced decay factors (tourism, atmospheric pollution due to traffic and rise of temperature and humidity), the susceptibility of the local building materials (porous sandstone) and an inefficient city development planning system (problems of stability of buildings, underground facilities etc).

Through a series of national and EU- funded research programs an integrated methodology for measuring and monitoring salt decay in the local porous stone was developed, which identified and mapped the critical areas of the fortifications, that required conservation-restoration interventions.

Appropriate building materials (compatible restoration mortars and replacement of stones) and consolidation treatments (through a reverse engineering methodology) were designed, applied and evaluated on pilot scale. Finally, in regard to the historic city center, techniques



2. - Archaeological site of Delphi.  
*Site archéologique de Delphes.*

and methodology for the preservation and environmental management were developed and applied to ensure its sustainable development.

The case of the Medieval City of Rhodes shows the complexity of the problems faced in built cultural environments, especially at the scale of a historic city, while it demonstrates the need of a “holistic” approach in dealing with them. (Moropoulou & Labropoulos, 2015).

The famous **archaeological site of Delos** (fig. 3) is inscribed in the UNESCO’s World Heritage List since 1990. The island of Delos was one of the principal Pan-Hellenic sanctuaries. The island’s landscape consists solely of ruins unearthed systematically since 1872. The archaeological site is estimated to cover a surface of 95 ha, of which 25 ha have been excavated till today but research is on-going.

The location (proximity to the sea) and the setting (in the middle of the Aegean Sea) of the site encompass threats and risks for the ruins. All the ancient structures or sculptures standing in the open air are exposed to various environmental factors, winds, rising sea and groundwater

levels and many others. The weather conditions in general have an impact on the architectural heritage of the site.

The climate of the Cyclades itself follows the basic parameters of the Aegean Sea climate, which is typically Mediterranean: mild winters and hot summers, strong hydrothermal variations during the transition periods and generally very few rains. The most characteristic parameter of the Aegean climate is the existence of the etesian winds. Although they are present only during



3. - Archaeological site of Delos.  
*Site archéologique de Délos.*

the hot months of the year their influence on the climate of the area is so strong that it is usually referred to as the “Etesian Climate”. As the wind is mostly northern it is consequential that most effects on the monuments are in the northern side of the island. The next most frequently encountered wind is the Sirocco, which comes from the South. It carries particles from the African deserts and often results in mud rains. Over the last decade, the climate of the Cyclades is also influenced by global climate change and the rising of the sea level. At the conference “Climate Change and its Impact on Preservation Management of Archaeological Sites”, which was held in Athens (2<sup>nd</sup>-4<sup>th</sup> April, 2012) with the participation of ICORP’s representatives, evidence was presented that climate change is mostly resulting in very strong side winds and torrential rains which are very destructive.

The wind undoubtedly affects the building materials, and after long-term action the abrasive impact can lead to significant changes to all exterior parts of the structures. In the case of Delos the air flow transports water, salts, pollutants and dust to the open air archaeological structures or sculptures. Minute drops of sea water carried by the wind form a hard crust on the surface of the mosaic floors and in some cases they cause exfoliation or minute cracks on the marbles. The wall paintings preserved in several ancient buildings are particularly susceptible to marine aerosols and they can be severely damaged. The salts crystallize selectively under the lime wash layer gradually causing its detachment from the mortar. Another issue is the rare but strong rainfall. The strong direct rain falling on the surface of the monuments removes the deposits of the surface and exposes new surfaces to pollutants. The results of the weathering raise serious implications for remedial and preventive conservation practice.

The change of sea level on the other hand comprises another risk to the integrity of the structures. The coastal areas of the island of Delos are rich in submerged Hellenistic archaeological vestiges. Recent fieldwork brought to light neighborhoods and port installations that were created at the peak of Delos’ urbanization period on the northeast area of the island and which today are partly submerged into the sea. This gradual submersion can be explained by changes in the

relative sea-level. Research suggests that the data obtained from Delos indicates 3 basic sea level changes: the first one at about – 3.6 m ( $\pm$  0.5 m) around 2000 BC, the second one at about – 2.5 m ( $\pm$  0.5 m) around 400 BC and finally the third sea level at about – 1 m ( $\pm$  0.5 m) around 1000 AD.

Recent continuous rise of the sea level due to global warming causes serious threats in regard to greater eventual loss of archaeological elements. This needs to be confronted according to methods already applied in similar cases worldwide, including broader monitoring and management action plans.

Because of such major problems throughout the world, UNESCO has adopted a Strategy on Risk Reduction at World Heritage Properties, and the World Heritage Centre has developed programs to include Disaster Risk Reduction as a basic factor of management, which also involves familiarizing the public in regard to this subject.

UNESCO, ICOMOS, ICCROM and ICOM several years ago started organizing special workshops on such issues.

The Olympia Workshop in 2008 produced a series of recommendations known as the Olympia Protocol for International Cooperation, which are still worth considering.

The main points of the protocol are:

#### **Conservation**

1. Establishment of a Clearing House on Disaster Risk Reduction.
2. International Workshops to introduce the Protocol, identify pilot sites, and facilitate the establishment of twinning arrangements.
3. Workshops to build capacities of concerned stakeholders and launch the development of appropriate disaster risk reduction strategies at selected sites.
4. Risk Assessment at selected pilot properties.
5. Socio-economic analysis and research on traditional skills and local knowledge systems relevant to disaster risk reduction.
6. Inter-institution Workshops on Disaster Risk Reduction at site level.
7. Seminars with local communities.
8. Mid-term International Workshop to review progress of the activities and validate methodologies for developing an appropriate risk management strategy at site level.

9. Development of disaster risk reduction strategies at selected World Heritage properties.
10. Follow up at Pilot Properties.

### Capacity building and Communication

11. Publications and dissemination of materials on the web.
12. Distribution of information to each region.
13. Development of a curriculum for a training course on disaster risk reduction.
14. Development of a component on disaster risk reduction within the World Heritage in Young Hands School Kit and activities.
15. International Day of Disaster Reduction at World Heritage Properties.

In conclusion it is very important to make the younger generation aware of and to educate them about these risks, to provide them with special educational programs, training, and information. For this purpose I became involved in a children's book entitled *The Land of Two Suns* under the auspices of the World Heritage Center and ICCROM. It is a fairy tale which seeks to make primary school students aware of the effects of climate change upon both the natural and cultural environments and the need for international, national but also personal action to deal properly with it.

Through this effort I wish to emphasize the need to sensitize the younger generation in regard to our environmental behavior and our future strategies on a world basis for the reduction of disasters regarding our heritage, as this is a basic component for the sustainable development and management of World Natural and Cultural resources in the coming years.

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