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"Experiences" in the subterranean environment as a risk factor for cultural heritage. The case of Nerja Cave (Malaga, Spain)

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ABSTRACT: Additionally to its conventional touristic use, subterranean environments, as the caves, have been used as places to celebrate diverse events, recently called "experiences". Caves are extremely fragile sites where minimal environmental changes can produce irreversible damages in their ecosystem and in the patrimonial values they hold. This work exposes the case of Nerja Cave (Malaga, Spain), where an International Music and Dance Festival is annually celebrated. The environmental monitoring of the event along years has allowed to know its negative impact in the cave: anomalous increases in the air and rock temperature and carbon dioxide concentrations and high levels of fungi concentration in the air, considered one of the main rock art biodeterioration factor, amongst others. The Nerja Cave Research Institute has designed and implement a specific conservation protocol aimed to prevent or minimize the impact produced by the celebration of this "experience" in the subterranean environment. This protocol could serve as a model for the adequate conservation of other cavities or heritage sites with similar characteristics where this type of activities is celebrated.

1 INTRODUCTION

In the last years, some authors are critical about the celebration of recreational activities in protected natural areas (Ballantyne et al., 2014; Ballantyne & Pickering, 2015; Newsome & Lacroix, 2011) by the significant impacts arising from them. Newsome & Hughes (2018) refer numerous examples of these activities (live concerts, theatres, movies, competitive sporting events, reality TV productions...) that require a management control and appropriate policy development to guarantee the conservation of the area where they are celebrate. For these researchers "the increasing visitor numbers coupled with a trending 'fast food' entertainment style of experience compromises the conservation mandate". In the tourist caves -and other subterranean environment- has been also created new modalities of interaction with the visitors, basically lights show, concerts and adventure activities. But the impact that "new activities" or "experiences" produce on the protected area is not sufficiently investigated or evaluated (Newsome & Hughes, 2018).

The Nerja Cave is one of the most important tourist caves in Spain, with about 450.000 visitors annually and it may answer many questions related to the biology, geology and archaeology of the subterranean environment. The cave preserves a chrono-cultural and paleo-environmental sequence which makes it possible to carry out many interesting interpretations of prehistoric settings (Jordá Pardo, 1986) and more than three hundred rock art paintings be-longing to the Upper Paleolithic and Late Prehistory (Sanchidrián, 1994) (Figure 1). Therefore, the cave is categorized as Asset of Cultural Interest, in the Archaeological Sites category and is also an internationally recognized Heritage Sight of Geological Relevance (García Cortés, 2008). Nevertheless, these fragile ecosystems can be disturbed by many anthropogenic and/or natural factors. The anthropic impact in Nerja Cave have been widely measured and studied. More information about this topic and the environmental

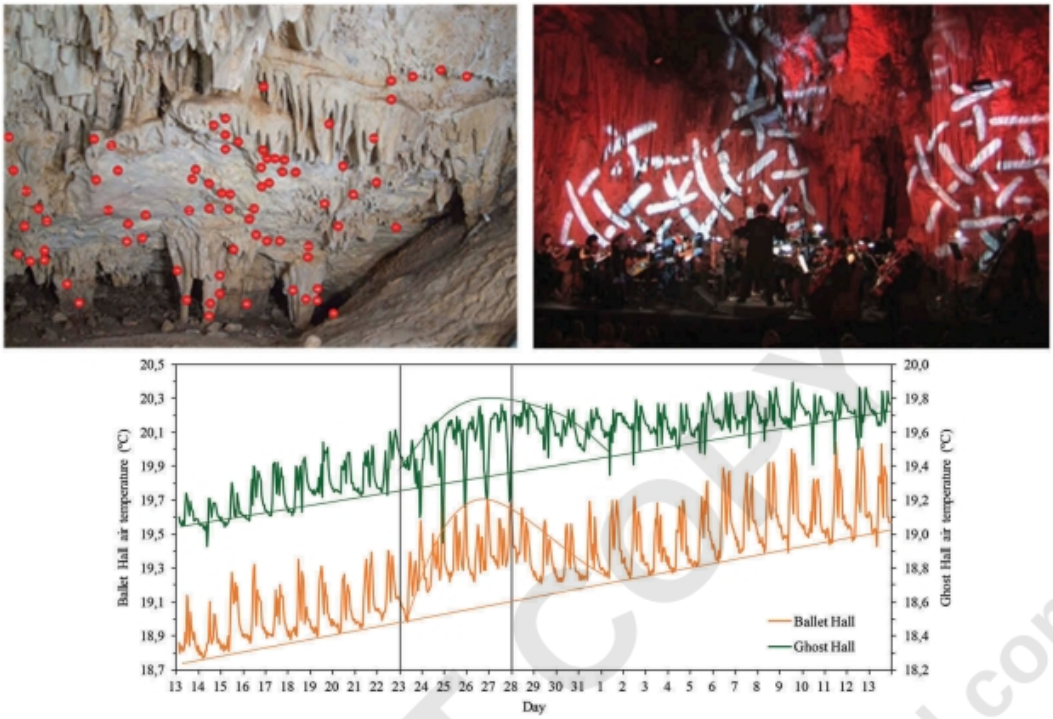

Figure 1. Up left: paleolithic pigment in the Ballet hall (PGI-CN, 2018). Up right: musical performance, during the cavity recovery time. Down: increases in air temperature during the festival (from 23 to 27 July) and several days after the end. Modified from Carrasco et al., (2002).

parameters of the cave can be consulted in Carrasco et al., (2002a), Del Rosal et al., (2007), Liñán & del Rosal (2015, 2016) and Liñán et al., (2018).

Since it was discovered in 1959, many human activities or "experiences" have been developed in the Nerja Cave in addition to the touristic visit. The aim of this work is to show that these "experiences" can represent an additional risk factor for the conservation of the caves and for Cultural and Natural Heritage they hold and the necessary application of specific protocols to avoid the anthropic damages. We presenter, as case of study, the annual International Music and Dance Festival of Nerja Cave.

2 "EXPERIENCES" IN NERJA CAVE. THE MUSIC AND DANCE FESTIVAL

The Music and Dance Festival entails the development of musical performances within the cave during several days of summer, normally in July. During the Festival period, the Nerja Cave Research Institute intensifies the environmental monitoring and vigilance of the cavity (I.I.C.N. 2002-2018), because:

(1) the Festival requires the installation in the subterranean environment of infrastructures such as the stage, sound systems, artistic lighting and seating for the public (Figure 2). These elements can damage the walls, speleothems and potentially, the rock art (accidental incisions, scratches, paintings, etc) when used as a direct support.
(2) the presence of these allochthonous objects in the cave induces the development of microorganisms, especially fungi, considered one of the main factors causing the biodeterioration of the rock art (Figure 2) (Sáiz, 2012; Martín-Sánchez et al., 2014).
(3) during the shows, the established habitual capacity and the average time of people in the cave is exceeded and the audience remains in the same hall (the Ballet Hall) for about two hours.

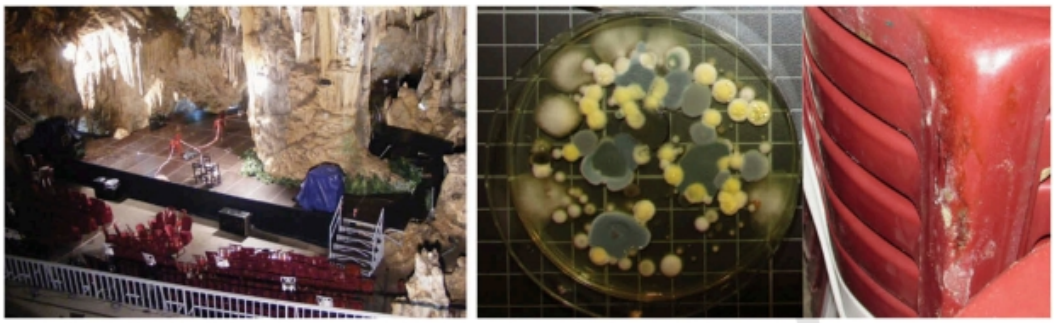

Figure 2. The festival requires the installation of infrastructures which can damage the walls, speleothems and the rock art (left). Petri dish with fungi colonies from a cave air sample (middle). Chairs with fungi colonies development (right).

Both facts generate an additional anthropic impact in the cave that adds to the daily impact produced by the tourists' visits, which reflects in anomalous increases registered in the air and rock temperature and carbon dioxide concentrations, amongst others, which persist in the cave during several days after the end of the event (Carrasco et al., 2002b) (Figure 1). All this indicate that the recovery capacity of the cave is not enough to eliminate the impact of the Festival during the night (closed period of the cave), in contrast to another days of normal visitability, in which the anthropic impact disappear during the night.

(4) the presence of the infrastructures installed for the Festival in the subterranean landscape damages to the institutional image of the Nerja Cave, alters visitor touristic experience and limit understanding of the natural and cultural environment (Zhang et al., 2009).

3 CONSERVATION PROTOCOL

To limit the risk involved in holding these festivals within the cavity, the Nerja Cave Research Institute has put in place a series of measures which form the Conservation Protocol:

(1) Preventative measures: the main aim of these measures is to prevent damage to the cave itself caused by the installation of the necessary infrastructure (such as the stage, seating, lighting, etc.), the presence of people and the development of potentially contaminating agents. The contemplated measures include: a reduction in the number of shows held in the cave; a physical protection for the most fragile elements, with the fragility being due to either the nature of the object (the rock art) and/or the actual location of the elements which may be close to the infrastructure installed; a reduction in the number of spectators admitted, thus diminishing the space needed for the audience; to maximize the cleanliness of the objects introduced into the cave as well as the concrete floor of the hall where the shows are held; to prohibit any material of a porous nature or made up of organic material and limit the time autochthonous elements can remain in the cave.

(2) Environmental control measures: these measures should be set up both in the days prior to the event and in the days after the event to specifically control the environmental and biological parameters in the air, water and substrate in order to identify possible alterations related to the event itself and its ongoing impact.

(3) Training measures: these measures are aimed at the workers in the cave; especially those involved in setting up the installation of the infrastructure for the events and the dismantling it afterwards. The objective is to involve workers in the conservation of the natural and cultural heritage of the Nerja Cave.

4 CONCLUSIONS

The uncontrolled development of events or "experiences" can represent a risk factor for the conservation of the caves and for the rock art, especially if appropriate preventive and/or corrective measures are not carried out. It has been registered diverse impacts on the subterranean environment linked to the holding of the Music and Dance Festival in the Nerja Cave. To minimize this impact and reduce risk to the conservation of the cave, the Research Institute has designed a protocol of measures specifically related to this type of "experiences". This protocol, in use since 2013, has allowed to diminish the damage caused by the Festival to the cultural heritage and the impact to the subterranean environment, although some damage continues to occur. Therefore, the current recommendation is to eliminate events of this type within caves, especially those which are part of our cultural heritage.

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