Archaeology on fire. Remote sensing based approach for the damage analysis: the case of Ventarron in Peru

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1 Fire among the major risks of cultural heritage

Fig.1 Notre-Dame on fire

Recently wildfires and burned areas have increased dramatically throughout the world affecting even more frequently urban-rural interface areas and more often cultural heritage and archaeological sites which of course demand much more than the normal protective measures used in urban–forest interface.

Fire risk assessment at a local scale should will include and support management of cultural heritage sites threatened by wildfires. Recent improvements in earth observation techniques (including both active and passive sensors from satellite, aerial and in situ technologies) offer data which can enable new applications specifically for the documentation, assessment and monitoring cultural heritage and UNESCO-inscribed sites. In particular, the availability since 2000 of both passive and active Very High Resolution (VHR) data along with the low cost of unmanned survey can suitably support quantitative evaluations of fire risk and fire impact on cultural heritage that represents the reference point of our identity, both current and future and are unreplaceable because unique.

Therefore, the protection of CH for the benefit of future generations is one of the main tasks of our society. The term "protection" is complementary to terms such as "safeguard", "conservation", "restoration", and, therefore, the protection constitutes the implementation of all the actions that aim to prevent damage before the disaster (prevention), or, in the case of event, to estimate the adverse impact to support the restoration interventions to minimize damage and losses (Lasaponara & Masini 2017).

Historical buildings and monuments (from palaces to churches) are usually characterized by materials with low resistance to fire (wood of the roofs, canvas, textiles), whereas the archaeological sites are almost mainly made up of stone and/or brick masonry structures, but often archaeological sites are (i) located in extra-urban contexts adjacent to vegetated areas, wooded or cultivated, which due to their potential vulnerability to ignite may constitute a risk factor for any adjacent archaeological areas, (ii) 'protected' by structures made using construction materials with low resistance to fire.

Fire represents one of the major risks affecting cultural heritage properties around the world. Although compared to other risks (flooding, landslide, etc) fires may be considered as "rare events", their impact is generally catastrophic, causing the total or almost total loss of cultural heritage. Recent examples include the Glasgow School of Arts (2014 and 2018), the National Museum of History and Natural Sciences in India (2016), the Maritime Museum of Jakarta (in 2018), and the Cathedral Notre-Dame de Paris (2019: see fig. 1) (ICCROM 2019). The fire event occurred in 2007 close to Olympia (Greece) represents an emblematic case of an interface fire that, not only affected vegetation, but also caused damage to the adjacent urban areas, including the archaeological site.

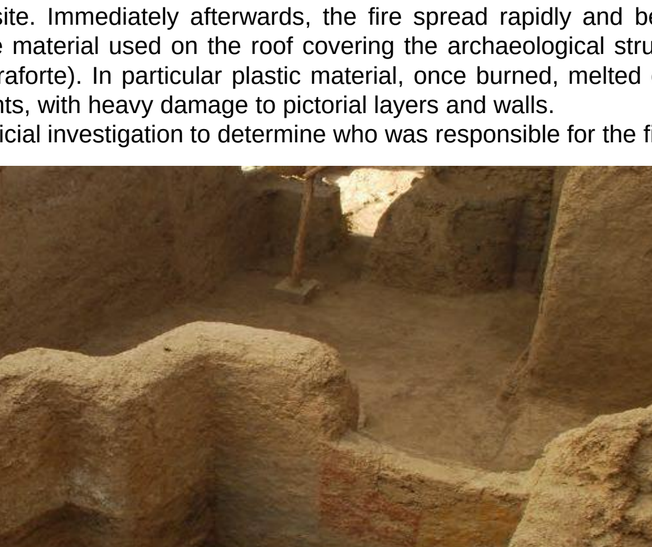

Fig.2 Location and satellite image of Ventarron

2 Methodological approach and case study

This paper deals with an emblematic case of interface fire occurred in Lambayeque region, in Northern Peru (fig. 2), on November 12, 2017, which devastated Huaca-Ventarron, including a mural painting believed to be the oldest discovered in the Americas (CNN 2017) .
Huaca Ventarrón, built over 1000 years from 4600 to 3500 before the present, is considered the cradle of prehispanic civilization in Northern Peru (Alva 2008). The archaeological investigations started in 2007 proved that in Lambayeque, an extremely complex civilization emerged, due to its sophisticated architecture and first use of mural art in America (National geographic 2007).
Ground documentation, drone flights and satellite acquisitions showed that the fire was caused by the burning of weeds of a sugar company in the contour of the fields, adjacent to the archaeological monument. The fire began as part of the regular work of burning fields. It was also found that the burning of weeds was not controlled and spread for more than 200 meters in favor of the wind. The fire in its uncontrolled route reached the roofs of the warehouses located on the west side of the archaeological site. Immediately afterwards, the fire spread rapidly and became uncontrollable due to the flammable nature of the material used on the roof covering the archaeological structures (bituminous tablet, Onduline, plastic plates of Fibraforte). In particular plastic material, once burned, melted on the most important murals and architectural components, with heavy damage to pictorial layers and walls.
The Peruvian Ministry of Culture announced an official investigation to determine who was responsible for the fire.

Fig.3 Ventarron : Painted earthen walls

3 Preliminary results

Remote and proximal sensing tools, from satellite data to images acquired from drones, could help to identify responsibilities, destructive dynamics of the event, possible errors in the management of agricultural fields. With such regard, the multitemporal data set (figure 5 a-d) available from Google Earth evidenced that before 2016 March (figure 5a-b), the area where the fire started, was not cultivated and characterized by sparse herbaceous cover, with a (conscious or unaware?) function of firebreak. From March 2016 up the fire event the plot of land adjacent the archaeological site was covered by cultivations (figure 5c), eliminating the fire cut function that probably would have made the fire less destructive.

Fig.4 Ventarron: the most ancient mural painting in America

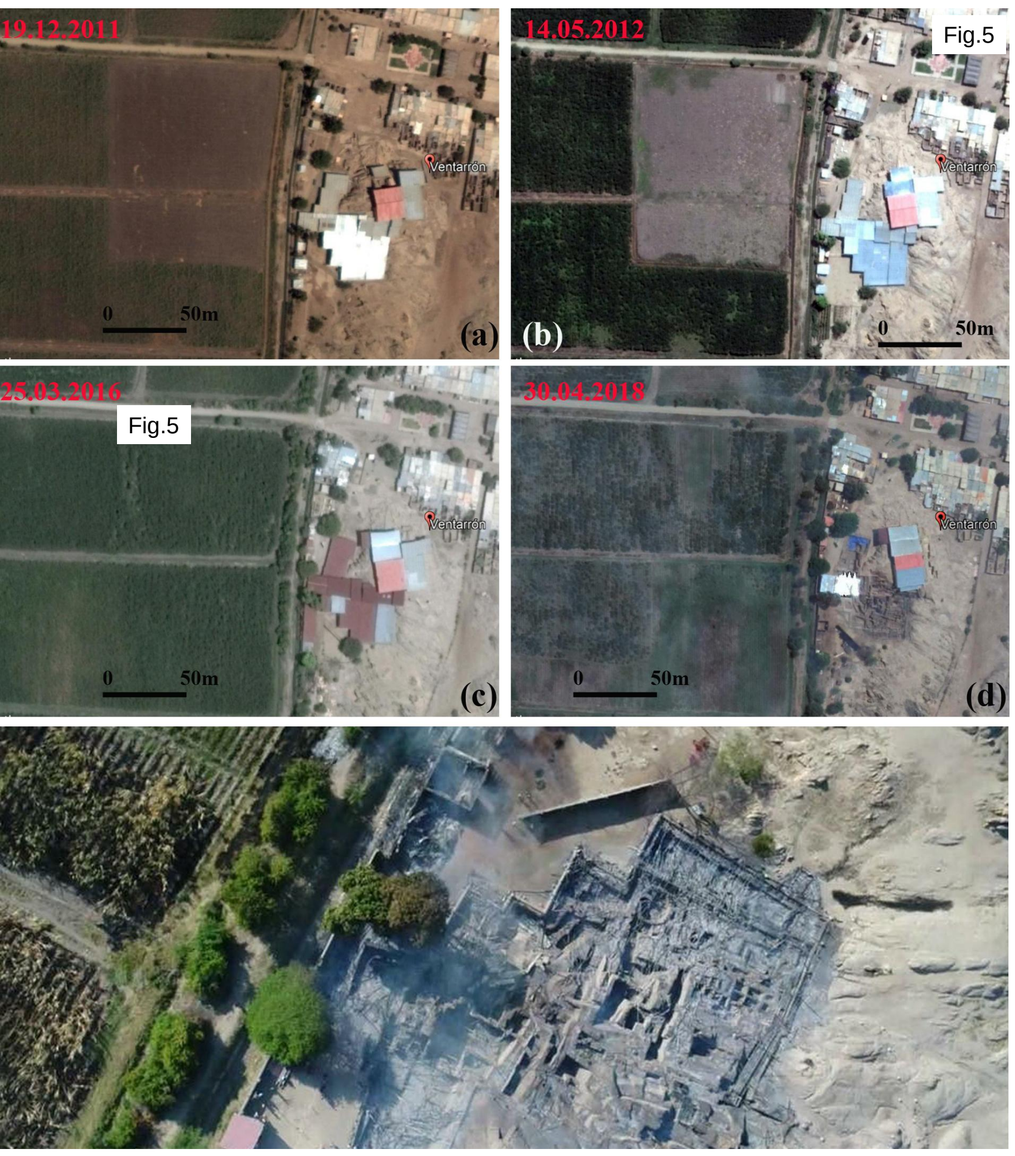

Fig.5

Fig.5 (a-d) Satellite multitemporal data set; (e) aerial image taken from drone (courtesy by Ignacio Alva)

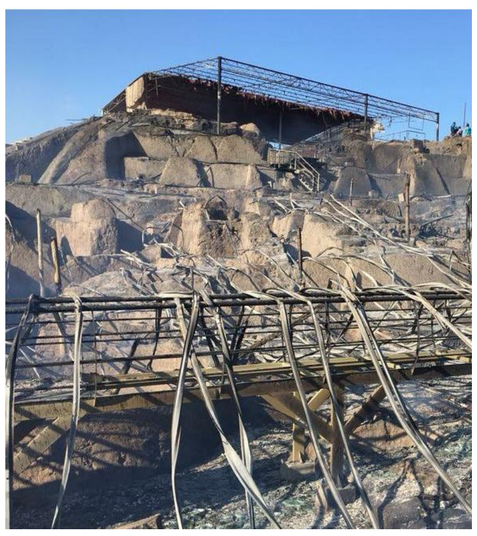

Fig.6 (Sx) Roof of the monument on fire (courtesy by Ignacio Alva); (medium and right) Damage caused by the fire (courtesy by Ignacio Alva)

Reference

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