ATHENA project: training activities for the detection of looted archaeological sites

Diofantos Hadjimitsis[1], Andreas Christofe[1], Athos Agapiou[1], Vasiliki Lysandrou[1], Themistocleous K.[1], Rosa Lasaponara[2], Nicola Masini[3]

[1] Eratosthenes Research Centre, Remote Sensing and Geo-environment Research Lab, Department of Civil Engineering Geomatics, Cyprus University of Technology, Saripolou Str. 2-8,3036 Limassol, Cyprus

[2] National Research Council , Institute of Methodologies for Environmental Analysis, C.da S. Loya, 85050 Tito Scalo, Italy

[3] National Research Council, Institute of Archaeological Monumental Heritage, C.da S. Loya, 85050 Tito Scalo, Italy

Abstract

A core element of the ATHENA Horizon 2020 funded project is knowledge transfer, achieved primarily through intense training activities (including virtual training courses, workshops and summer schools) with an ultimate scope to enhance the scientific profile of the research staff and to accelerate the development of research capabilities of the Eratosthenes Research Centre (ERC), placed in Cyprus. In addition, the project aims to promote Earth Observation knowledge and best practices intended for Cultural Heritage (CH). The preservation of CH and landscape is today a strategic priority not only to guarantee cultural treasure and evidences of the human past to future generations, but also to exploit them as a strategic and valuable economic asset (Masini & Soldovieri 2016). This is an extremely important key factor for the countries which are owners of an extraordinary cultural legacy, that is particularly fragile due to its specific characteristics and specific risks at which CH is continuously exposed (Brodie et al. 2001). Taking advantage of large-spatial coverage, high-spectral and sensitivity satellite remote sensing can be usefully adopted for contrasting looting. Satellite technologies offer a suitable chance to quantify and analyze this phenomenon, especially in several countries, from Southern America to Middle East (Casana 2015), where the onsite surveillance is not much effective or non-practicable due to military or political restrictions. Target training activities organized by the National Research Council (CNR, through IMAA and IBAM) are focused on the characterization of the looting phenomenon from a multi-faced prospective. These workshops are focused on the use of high spatial resolution satellite and aerial optical images as well as Lidar and geophysical data to quantitatively assess looting (Lasaponara et al 2014). An overview of methodologies and data processing for the identification and quantification of looting features (using both single date and multi temporal satellite images and object oriented classifications as in Lasaponara et al 2016) are discussed for several study areas.

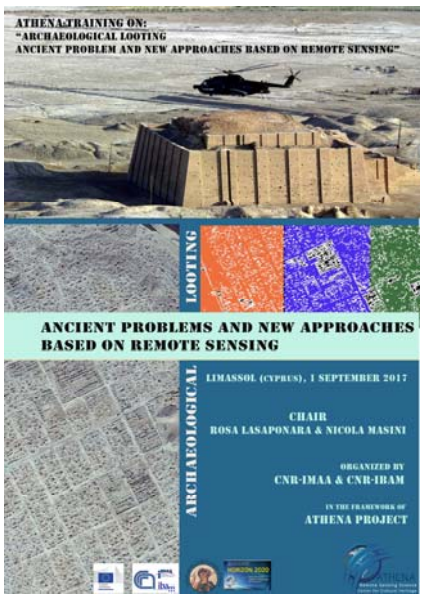
Introduction

Cyprus due to its geographical position has always been the crossroad between three continents: Europe, Africa, and Asia, the bridge between east and west. With the various wars and conflicts in the Middle east area, remote sensing techniques seem to be the most efficient, time effective way for monitoring CH's destruction even documenting CH prior its total extinction, as well as to monitor archaeological looting activities which represent one of the main risks affecting archaeological heritage throughout the world.

Actions oriented to prevent looting can be supported by satellite technologies which can provide reliable information to: (i) detect and quantify looting phenomenon even over large areas, (ii) set up tools to undertake monitoring also for remote areas or sites not accessible due to war or other limiting factors.

Recently, looting activities that have exponentially increased in the Middle East since the beginning of the conflict in Syria. in the middle east areas. To face this UNESCO and UNITED National provided additional efforts and adopted new actions to condemn and contrast looting activities The United Nations Security Council, on 12 February 2015, adopted the Resolution 2199 that condemns the destruction of cultural heritage and adopts legally binding measures to counter illicit trafficking of antiquities and cultural objects.

Basic overview of Looting and CH monitoring from space



The preservation of cultural heritage and landscape is today a strategic priority not only to assure cultural treasure and evidences of the human past to future generations, but also to exploit them as a strategic and valuable economic asset, if inspired to sustainable development strategies. This is an extremely important key factor for the countries which are owners of an extraordinary cultural legacy, which is particular fragile due to its specific characteristics and specific risks at which CH is continuously exposed. Taking advantage of large-spatial coverage, high-spectral and sensitivity satellite remote sensing can be usefully adopted for contrasting looting. Satellite technologies offer a suitable chance to quantify and analyse this phenomenon, especially in those countries, from Southern America to Middle East, where the surveillance on site is not much effective and time consuming or non practicable due to military or political restrictions.

The training activities organized and carried out by CNR were focused on the characterization of the looting phenomenon from a multi-faced prospective. In particular, the training activities were focused on the use of high spatial resolution satellite and aerial optical images and Lidar acquisition to quantitatively assess looting.

An overview of methodologies and data processing for the identification and quantification of looting features (using both single date and multitemporal satellite images) were discussed for several study areas.

Moreover, advanced data processing based on both autocorrelation statistics and unsupervised classification have been presented, applied and discussed for significant study areas, as Dura Europos; selected in Syria.

Example

Case Study Area

The area under investigation is in the southwestern part of the modern village of Politiko, in Nicosia District. In this area, looted tombs have been identified in the past, as well as in more recent years. The tombs are hewn out of the natural bedrock. Undisturbed tombs are not easily detected through aerial and/or satellite datasets since they are underground at an approximate depth of 3 m below the surface. In contrast, signs of looted tombs are more likely to be observed and identified in this manner.

Figure. Map indicating the case study area in the southwestern part of the modern village of Politiko, Nicosia District. Red dots indicate looted tombs (also shown right) which have been detected during the in situ investigation and mapped with GNSS (February 2016).

Aerial Orthophotos

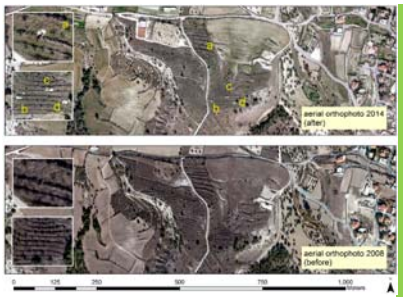
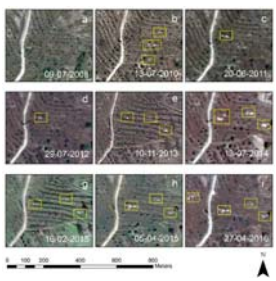


Photo-interpretation was carried out using the two aerial images taken in 2008 and 2014. These images were also improved using the linear percent stretch (5%) histogram enhancement technique. The earliest aerial image confirmed the results obtained from the satellite products of Google Earth©, indicating no looting attempts in the wider area of Politiko. Instead, at least four looting marks were spotted in the aerial image of 2014. Looting traces indicated as b–d in Figure 5 were also recorded in the Google Earth© image and confirmed by the in situ inspection.

Figure. Aerial RGB orthophotos taken in 2008 (bottom) and 2014 (top). Looted imprints (a–d) are traceable only in the latest aerial image.

Google Earth© Images



The investigation of the site initially started from the visual inspection of the Google Earth© images. Brightness and contrast adjustments were applied in an attempt to support the visual interpretation. Historical records from high spatial resolution images over the area of interest were examined, as shown in Figure 4. The images were imported and sorted in chronological order in a GIS environment. Even though the looted tombs were not visible in the images, looted areas were spotted based on the looting soil disturbance (in some instances achieved by using mechanical means). Recently disturbed terrain was clearly visible in the Google Earth© images.

Figure. RGB Google Earth© images over the area of interest between the years 2008 and 2016 as follows (a) 9 July 2008, (b) 13 July 2010, (c) 20 June 2011, (d) 29 July 2012, (e) 10 November 2013, (f) 13 July 2014, (g) 16 February 2015, (h) 5 April 2015, and (i) 27 of April 2016. Looted tombs are indicated by the yellow squares.

Info

www.athena2020.eu

Consortium

Cyprus University of Technology

National Research Council

German Aerospace Centre

Acknowledgments

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691936".