ATHENA

Remote Sensing Science Center for Cultural Heritage

H2020-TWINN-2015. Grant Agreement no 691936	
Project full title:	Remote Sensing Science Center for Cultural Heritage
Project acronym:	ATHENA
Work Package	WP5
Deliverable	D5.1 Leaflets

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Call:	Work programme **H2020** under **"Spreading Excellence and Widening Participation", call: H2020-TWINN-2015: Twinning** (Coordination and Support Action).
Project full title:	**Remote Sensing Science Center for Cultural Heritage**
Project acronym:	**ATHENA**
Work Package (WP):	**WP5**
Deliverable (D):	**D5.1 Leaflets**
Due date of deliverable:	**November 2018** **(Month 36 of the project)** — **Version: 1**
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Contributor(s):	**Rosa Lasaponara, Nicola Masini, Thomas Krauss, Gunter Schreier**
Start date of project:	**1/12/2015** — Duration: **36 months**

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CO	Confidential, only for members of the consortium (including the Agency Services)	

Document Sign-off				
Nature	**Name**	**Role**	**Partner**	**Date**
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APPROVED	Diofantos G. Hadjimitsis	Coordinator	CUT	27/11/2018

Work Package 5 – Promotion of the centre locally and internationally Deliverable: D5.1 – Leaflets				
Sections to be protected	**Description**	**Owner**	**Access Rights**	
			Period	**Type***
none				

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Summary

The specific deliverable is a collection of the special leaflets that were designed to inform stakeholders and other possible interested parties regarding the activities of the Remote Sensing lab within the framework of ATHENA project. For this purpose, 14 special leaflets were designed and uploaded on the project's website. Additional information will be provided to all interested parties via the WP6 deliverables of the project.

1. Introduction

Targeted presentations of the Centre and its services to stakeholders and possible interested parties, such as the Department of Antiquities of Cyprus, the Committee of Missing People, several foreign archaeological missions excavating in Cyprus. For this purpose, 14 special leaflets were designed and uploaded on the project's website (distributed in electronic and printed format).

In addition, during the lifetime of the ATHENA project these will be informed via WP6 deliverables (e.g. websites / brochures / presentations, etc). In-situ visits from the members of the RS Lab will be also performed to several sites under excavation and under archaeological study.

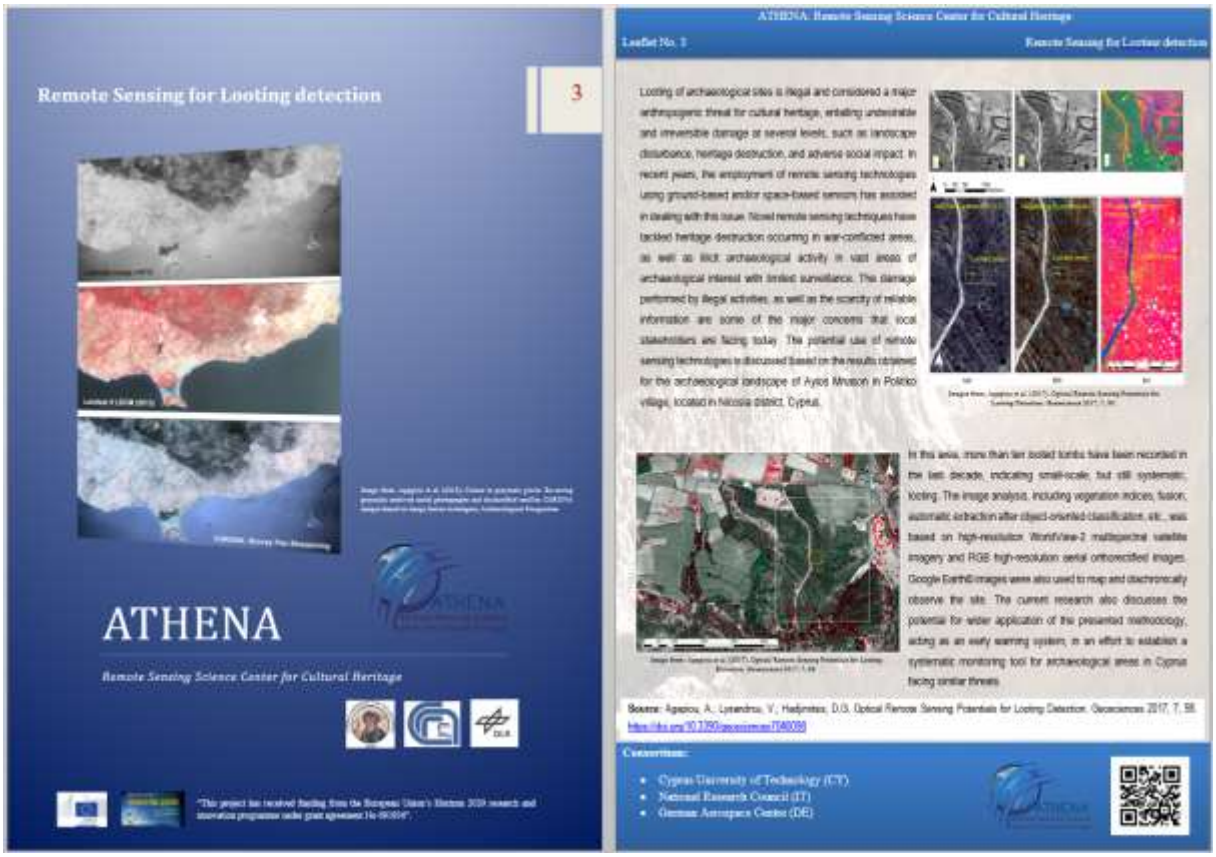
2. Leaflets

During the three years of ATHENA project 14 special leaflets have been designed and uploaded on the ATHENA project's website for informing the interested parties, stakeholders and the general public. Last but not least, leaflets were handed out during targeted presentations of the Centre, promotional events, such as Researcher's nights and other scientific conferences locally and on international level.

2.1 Introduction to ATHENA

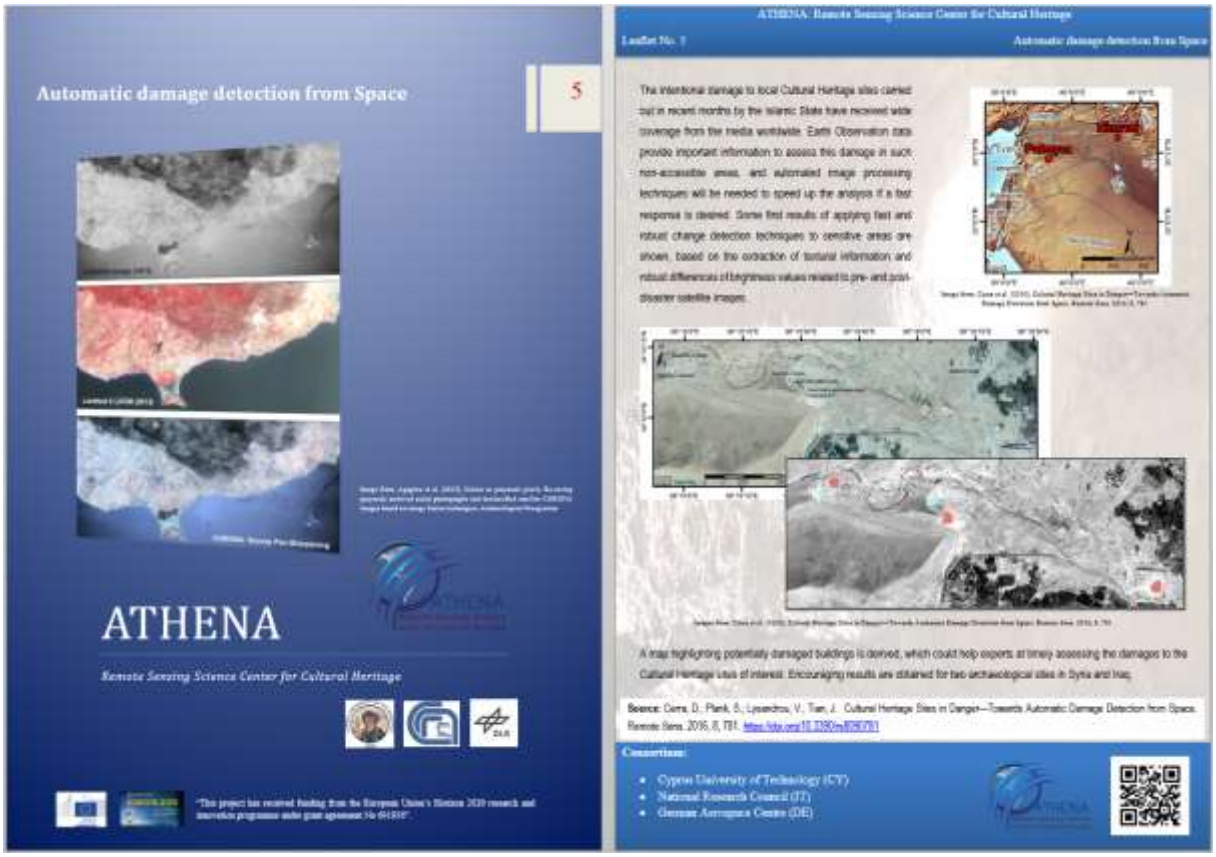
2.2 Hyperspectral indicators

2.3 Remote Sensing for Looting detection

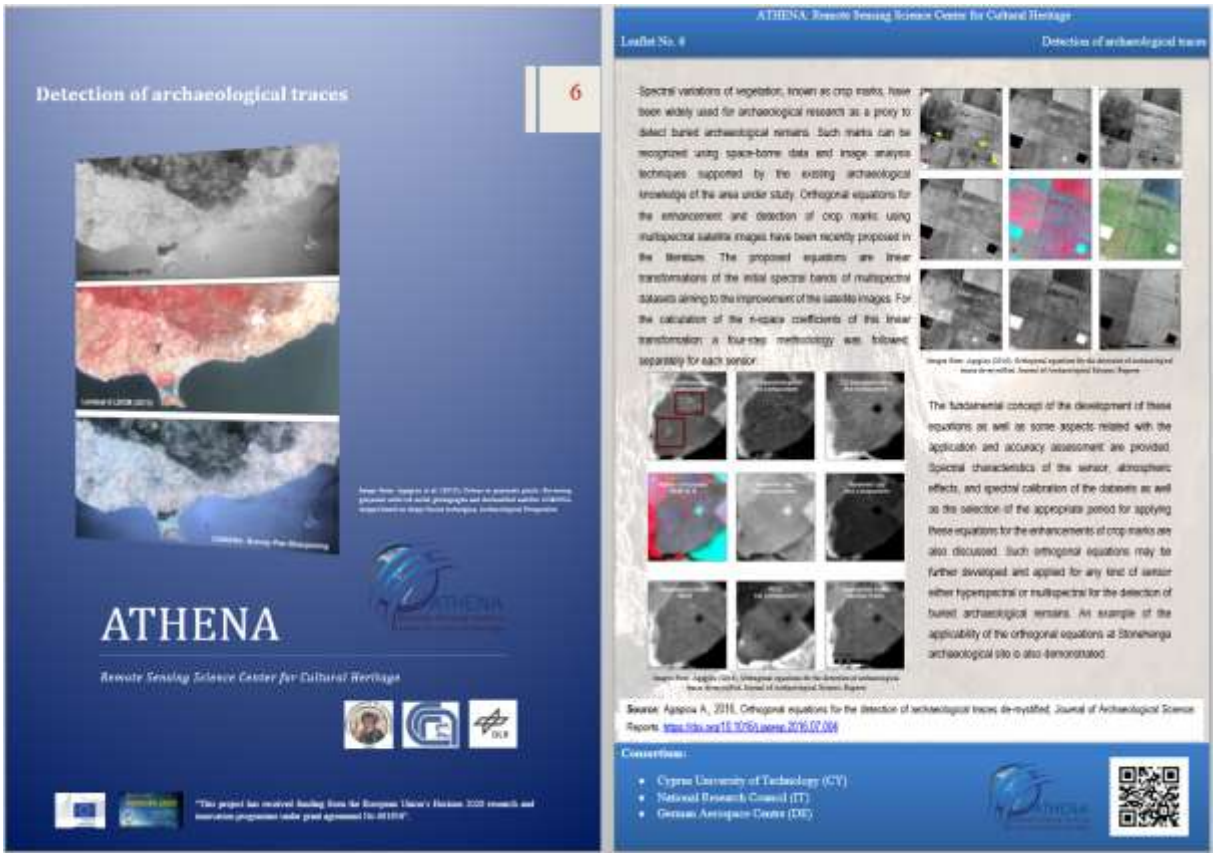


2.4 Correlating damage condition with historical seismic activity

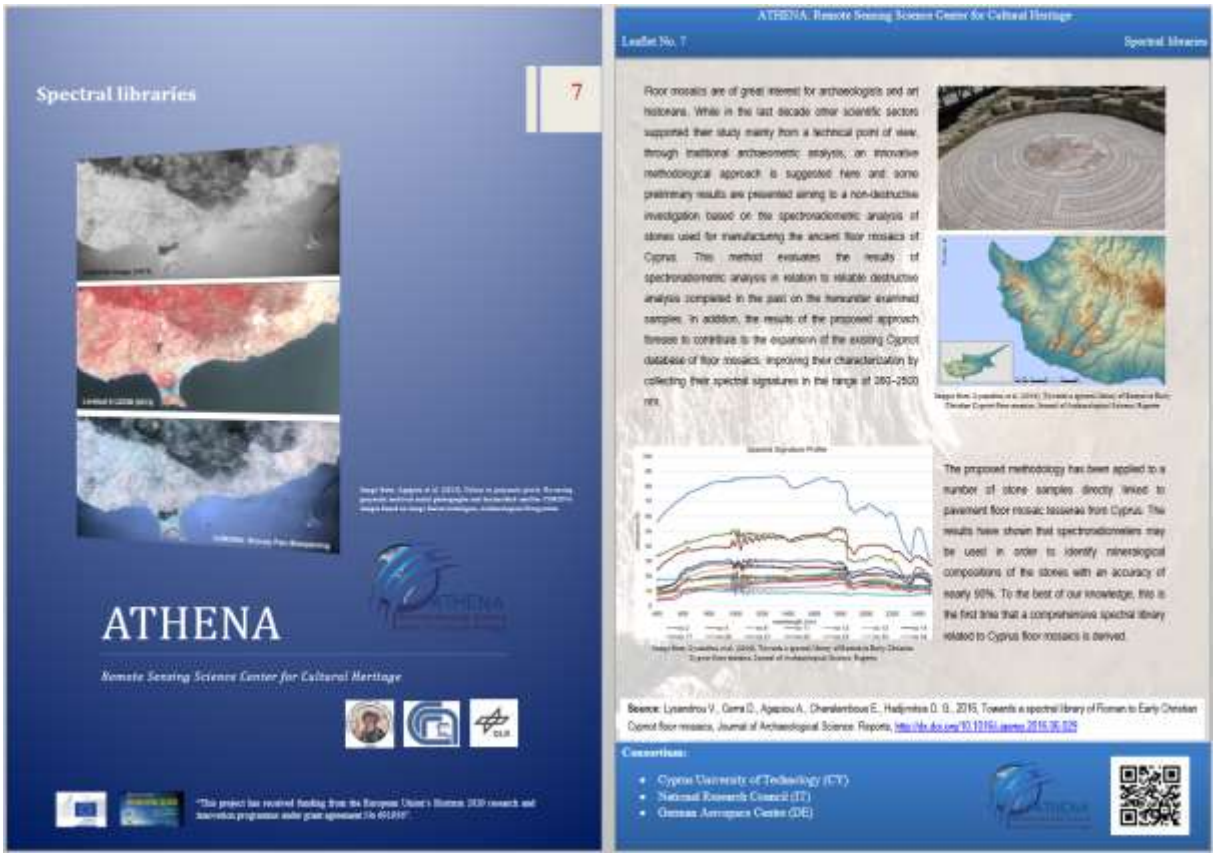
2.5 Automatic damage detection from space



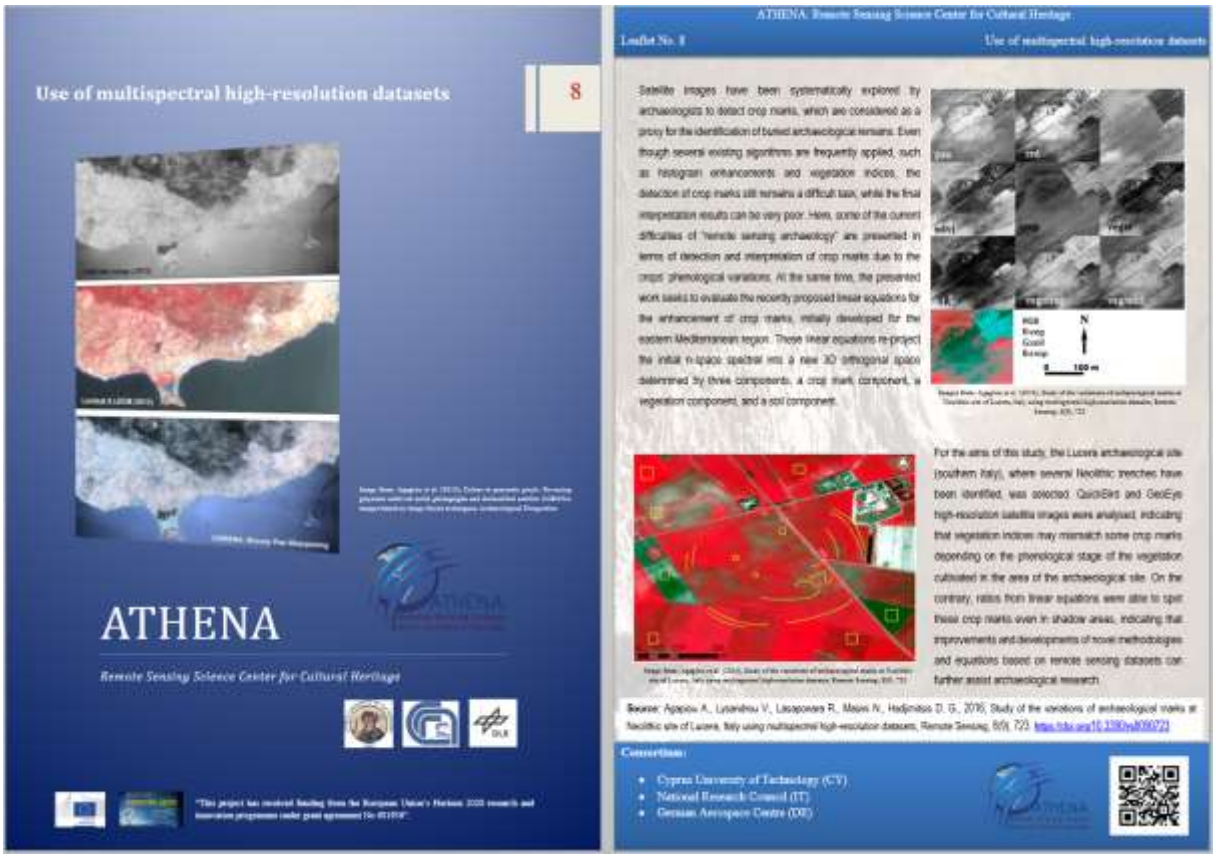
2.6 Detection of archaeological traces



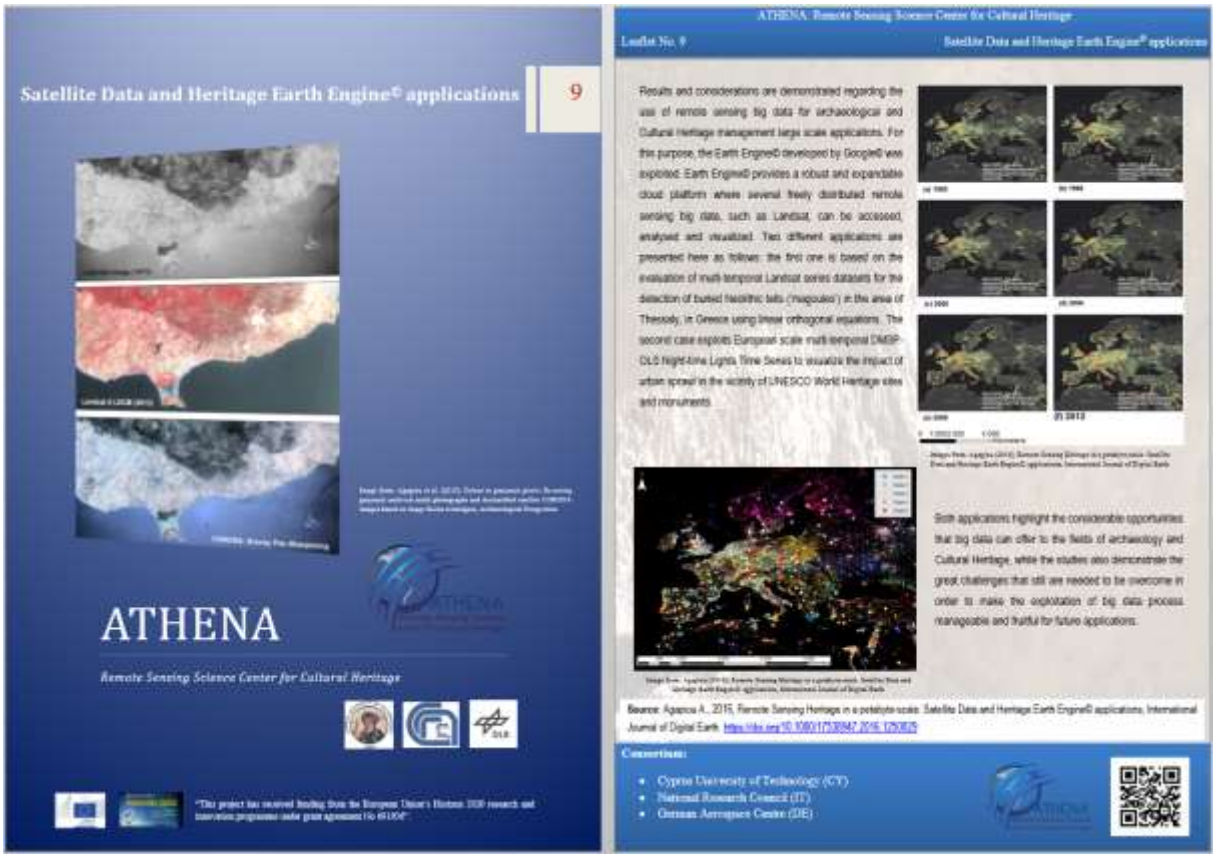
2.7 Spectral libraries



2.8 Use of multispectral high resolution datasets



2.9 Satellite Data and Heritage Earth Engine applications



2.10 Remote Sensing on Archaeological Research

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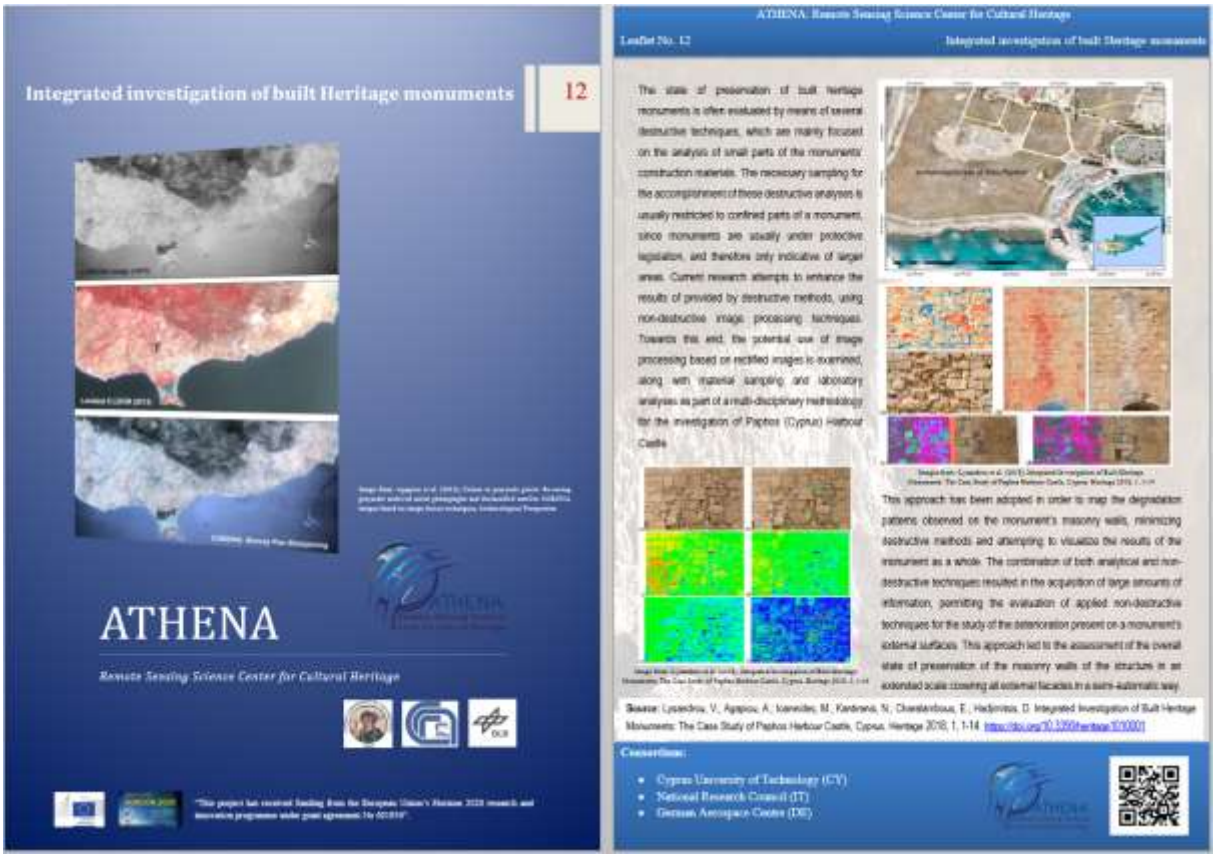

2.13 Digital documentation of Cultural Heritage

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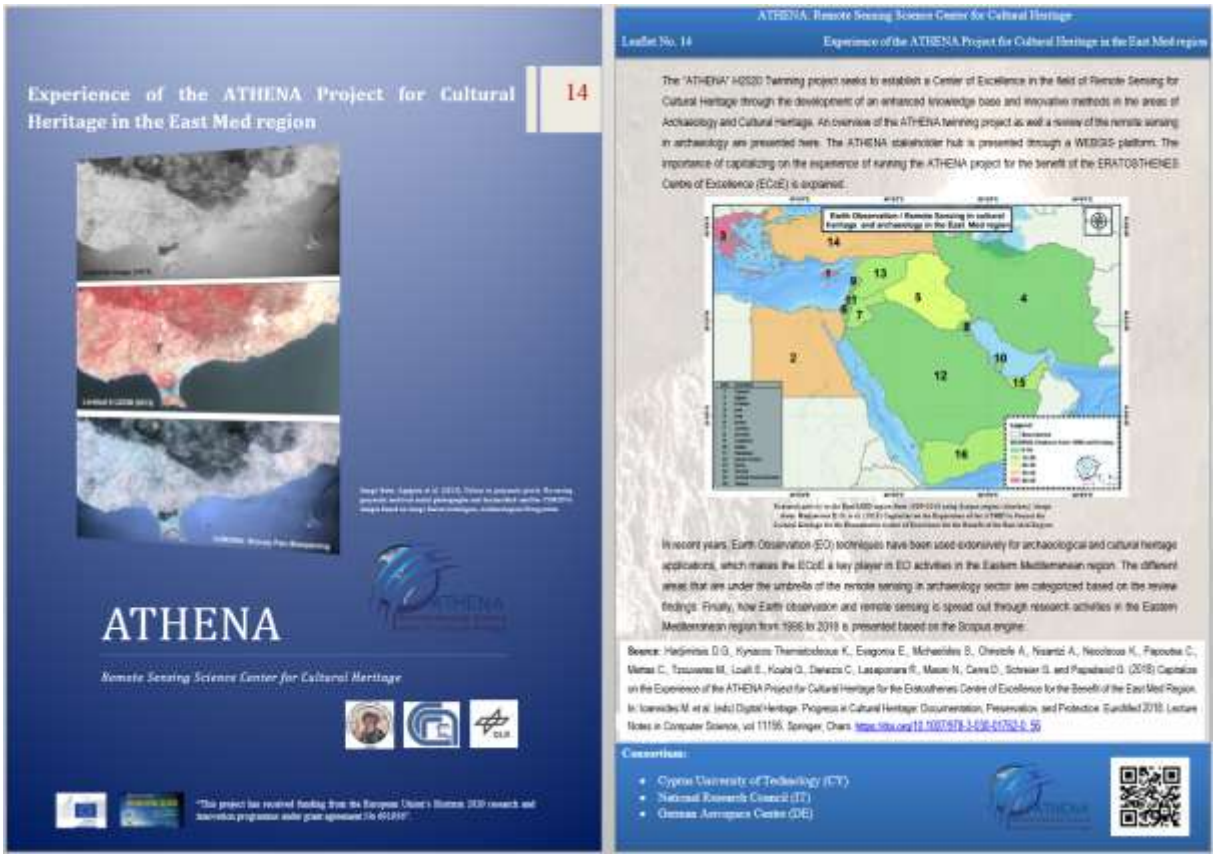

Annex

(Leaflets in full size)

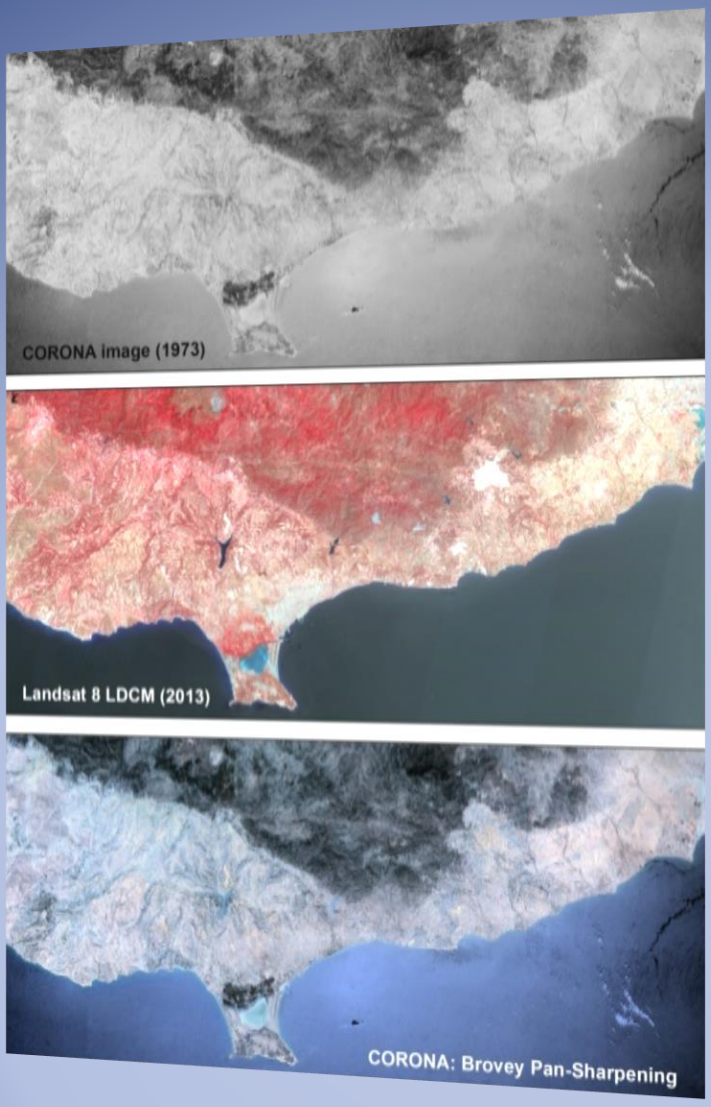

Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection (under publication)

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"In periods of economic instability, national considerations are overruling the process of European integration. Cultural Heritage (CH) is an integral element of a European set of values and respect for heritage is vital for developing a common European identity. CH sector has always been facing a number of challenges that have increased with the financial crisis that has hit Europe. To name a few, these challenges include the decrease of public budgets, urbanisation, globalisation and technological changes. Within this context, CH professionals are seeking to improve currently used methodologies, in order to better understand, protect and valorise the common European past and common identity"

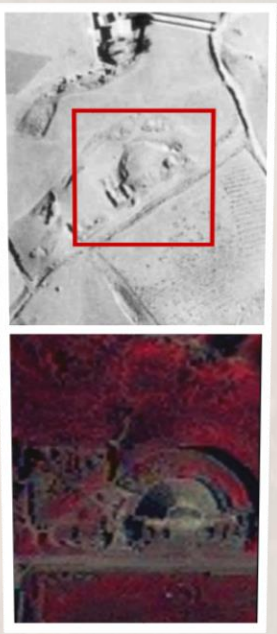

Image from: Agapiou et al. (2015), Impact of Urban Sprawl to archaeological research: the case study of Paphos area in Cyprus, Journal of Cultural Heritage, 16(5).

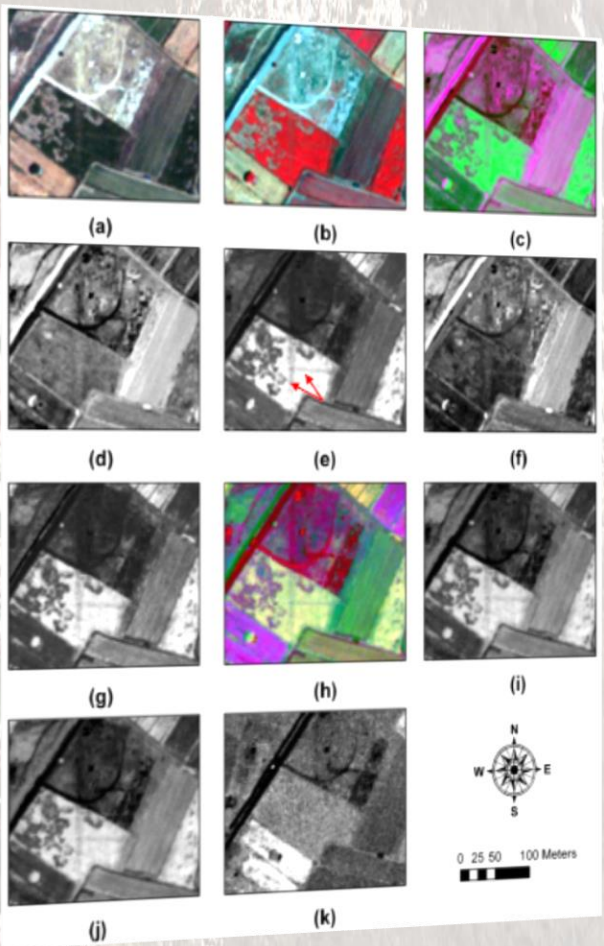

Image from: Agapiou et al. (2013), Orthogonal re-projection of spectral bands using medium and high resolution satellite images for the detection of archaeological crop marks. Remote Sensing, 5(12)

"The "ATHENA" proposal aims to establish a **Center of Excellence in the field of Remote Sensing for Cultural Heritage**. This center will be established by twinning the existing Remote Sensing and Geo-environment Research Laboratory at the Cyprus University of Technology (CUT) with internationally-leading counterparts from other Member States of the EU, such as the National Research Council of Italy (CNR) and the German Aerospace Agency (DLR).

The close collaboration between CUT and other experts in the field of Remote Sensing for Cultural Heritage in the EU will form a synergic network that will permit networking, transfer of knowledge and training of the existing personnel of CUT."

Consortium:

- Cyprus University of Technology (CY)
- National Research Council (IT)
- German Aerospace Centre (DE)

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Hyperspectral indicators

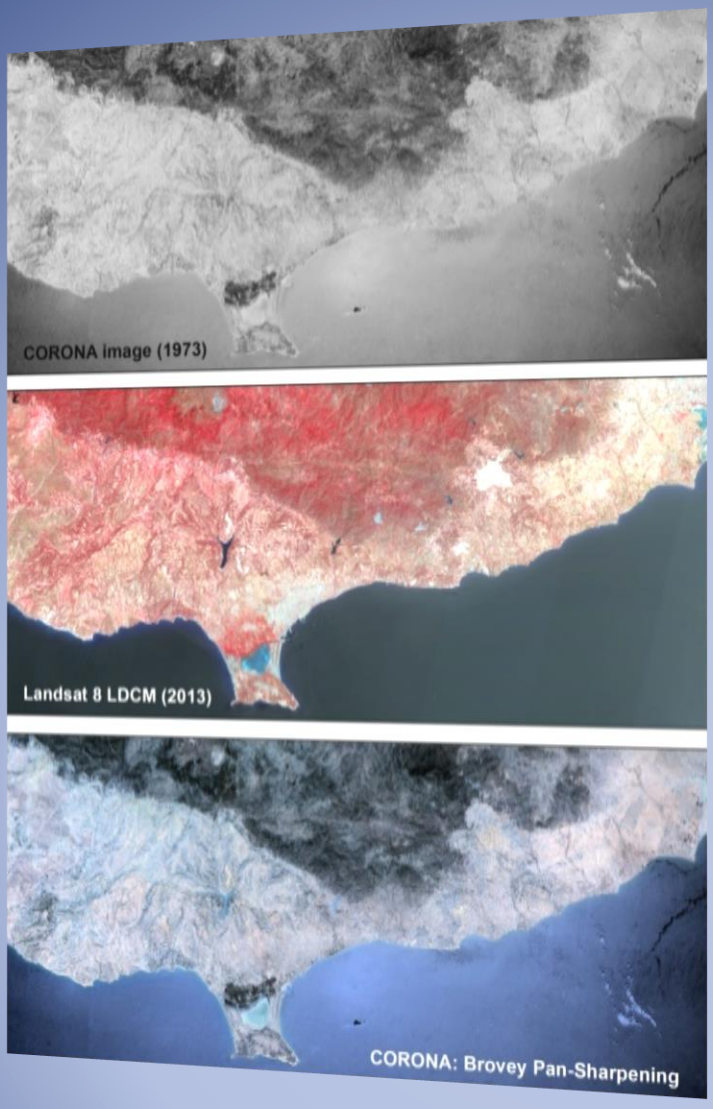

Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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Hyperspectral images can highlight crop marks in vegetated areas, which may indicate the presence of underground buried structures, by exploiting the spectral information conveyed in reflected solar radiation. In recent years, different vegetation indices and several other image features have been used, with varying success, to improve the interpretation of remotely sensed images for archaeological research. However, it is difficult to assess the derived maps quantitatively and select the most meaningful one for a given task, in particular for a non-specialist in image processing. The suitability of maps derived from spectral features is estimated objectively for the detection of buried archaeological structures in vegetated areas based on information theory.

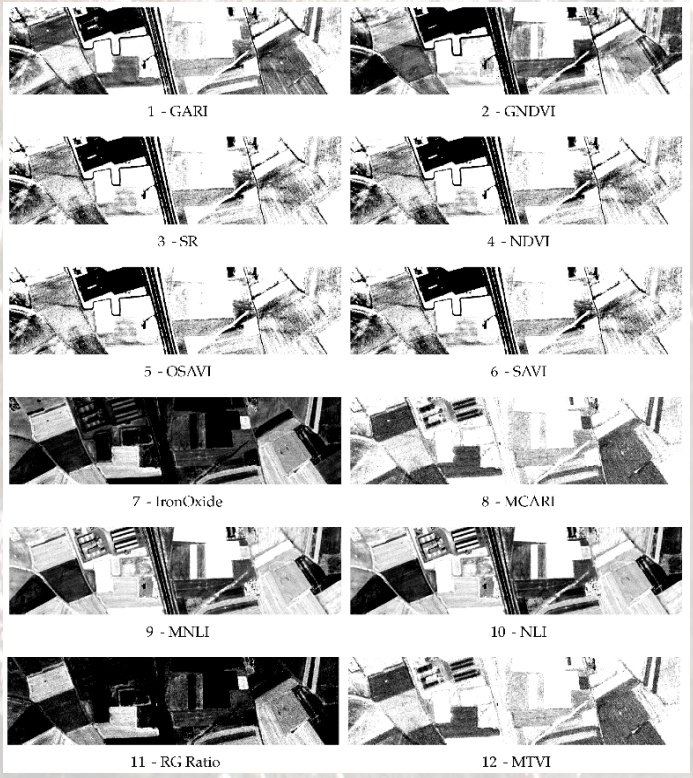
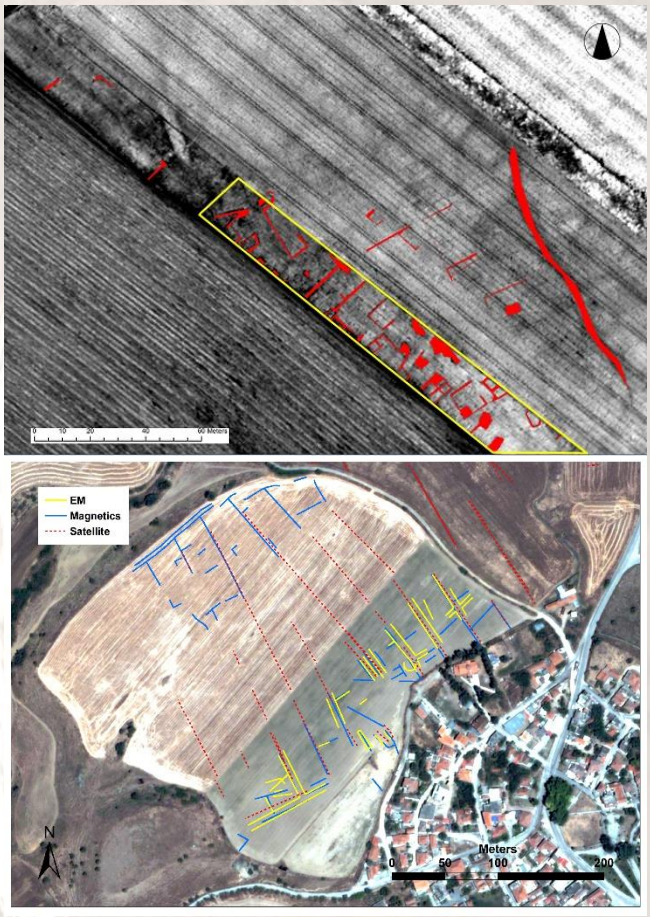


Image from: Cerra et al. (2018), An Objective Assessment of Hyperspectral Indicators for the Detection of Buried Archaeological Relics. Remote Sens. 2018, 10, 500.



Images from: Cerra et al. (2018), An Objective Assessment of Hyperspectral Indicators for the Detection of Buried Archaeological Relics. Remote Sens. 2018, 10, 500.

This is achieved by computing the statistical dependence between the extracted features and a digital map indicating the presence of buried structures using information theoretical notions. Based on the obtained scores on known targets, the features can be ranked and the most suitable can be chosen to aid in the discovery of previously undetected crop marks in the area under similar conditions. Three case studies are reported: the Roman buried remains of Carnuntum (Austria), the underground structures of Selinunte in the South of Italy, and the buried street relics of Pherai (Velestino) in central Greece.

Source: Cerra, D.; Agapiou, A.; Cavalli, R.M.; Sarris, A. An Objective Assessment of Hyperspectral Indicators for the Detection of Buried Archaeological Relics. Remote Sens. 2018, 10, 500. https://doi.org/10.3390/rs10040500

Remote Sensing for Looting detection

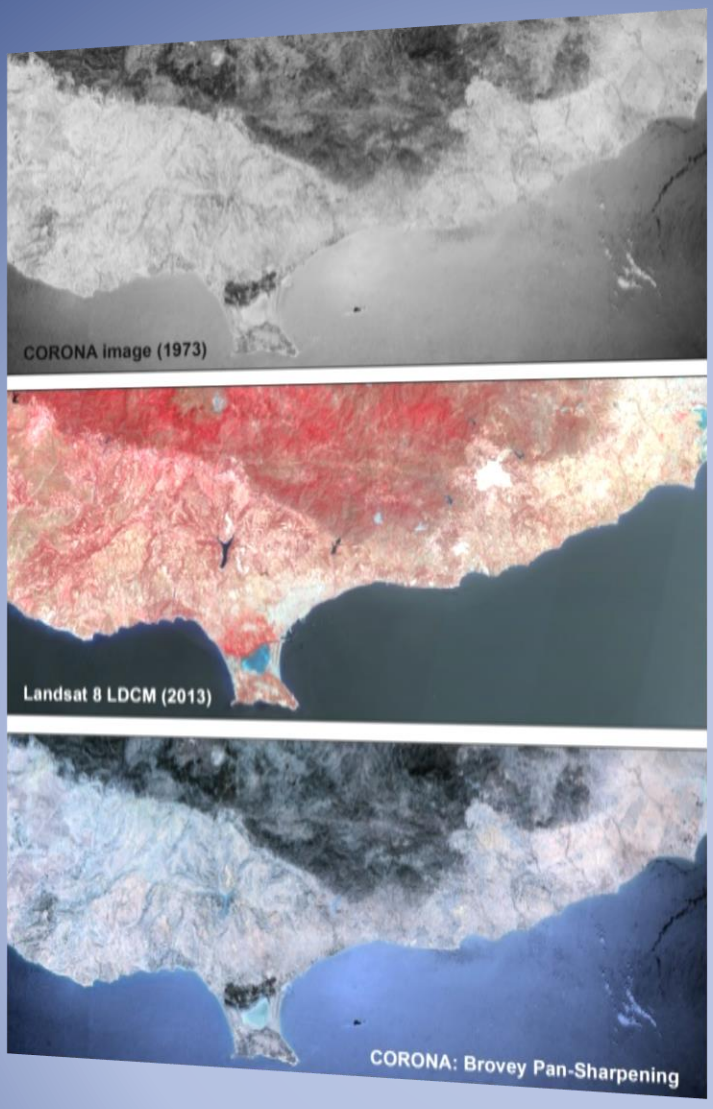


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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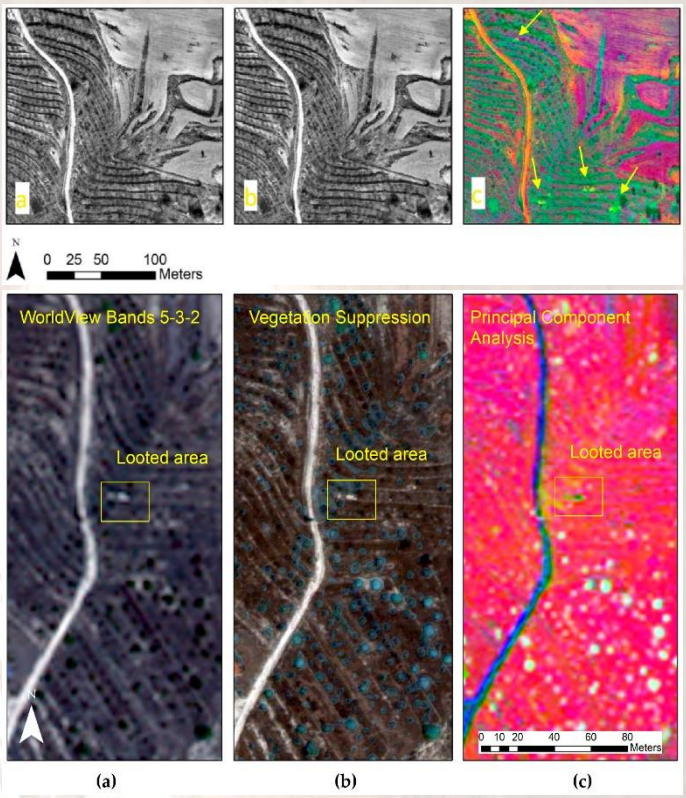
Looting of archaeological sites is illegal and considered a major anthropogenic threat for cultural heritage, entailing undesirable and irreversible damage at several levels, such as landscape disturbance, heritage destruction, and adverse social impact. In recent years, the employment of remote sensing technologies using ground-based and/or space-based sensors has assisted in dealing with this issue. Novel remote sensing techniques have tackled heritage destruction occurring in war-conflicted areas, as well as illicit archaeological activity in vast areas of archaeological interest with limited surveillance. The damage performed by illegal activities, as well as the scarcity of reliable information are some of the major concerns that local stakeholders are facing today. The potential use of remote sensing technologies is discussed based on the results obtained for the archaeological landscape of Ayios Mnason in Politiko village, located in Nicosia district, Cyprus.



Images from: Agapiou et al. (2017), Optical Remote Sensing Potentials for Looting Detection. Geosciences 2017, 7, 98.

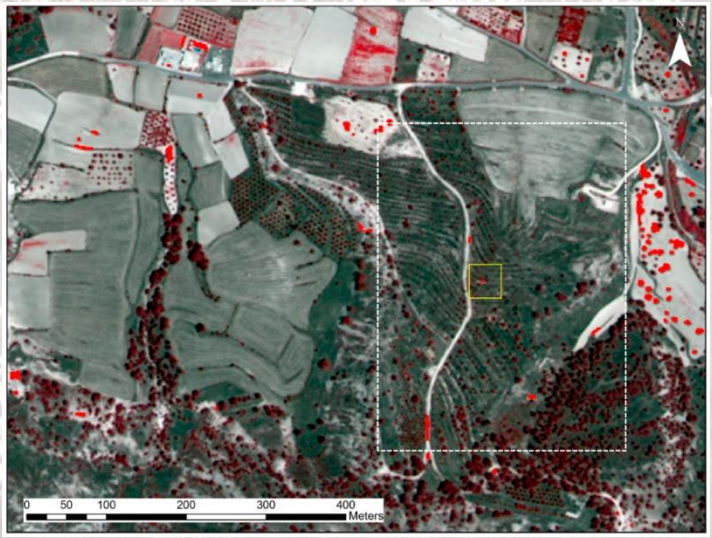


Image from: Agapiou et al. (2017), Optical Remote Sensing Potentials for Looting Detection. Geosciences 2017, 7, 98.

In this area, more than ten looted tombs have been recorded in the last decade, indicating small-scale, but still systematic, looting. The image analysis, including vegetation indices, fusion, automatic extraction after object-oriented classification, etc., was based on high-resolution WorldView-2 multispectral satellite imagery and RGB high-resolution aerial orthorectified images. Google Earth© images were also used to map and diachronically observe the site. The current research also discusses the potential for wider application of the presented methodology, acting as an early warning system, in an effort to establish a systematic monitoring tool for archaeological areas in Cyprus facing similar threats.

Source: Agapiou, A.; Lysandrou, V.; Hadjimitsis, D.G. Optical Remote Sensing Potentials for Looting Detection. Geosciences 2017, 7, 98. https://doi.org/10.3390/geosciences7040098

Correlating damage condition with historical seismic activity

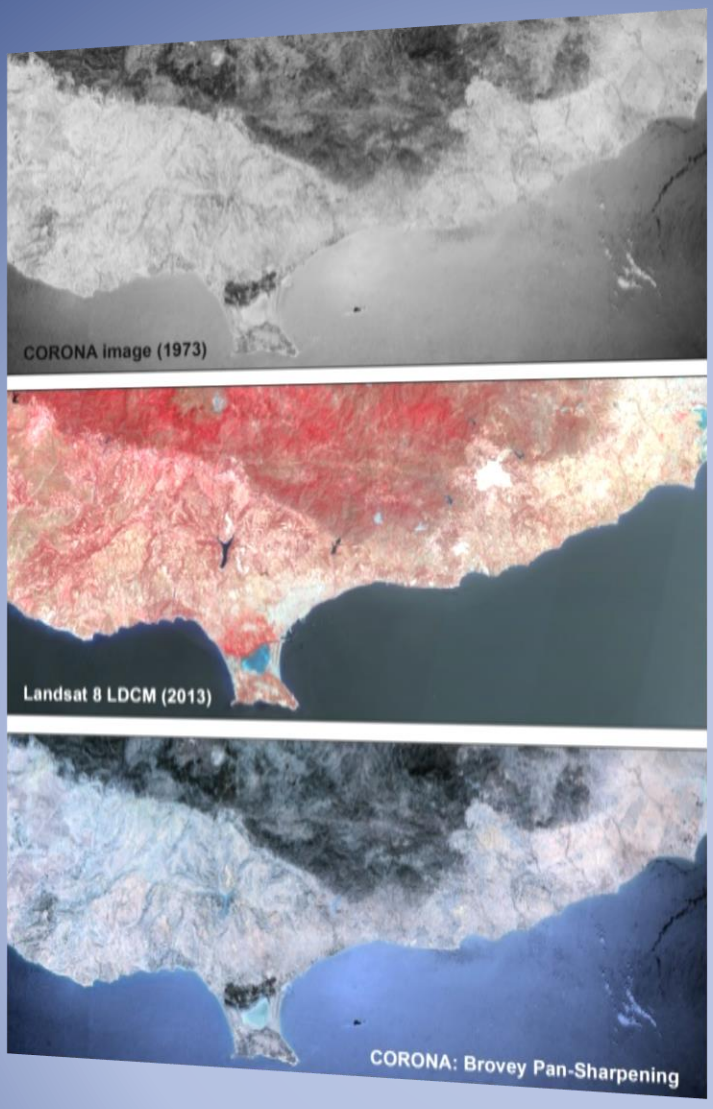


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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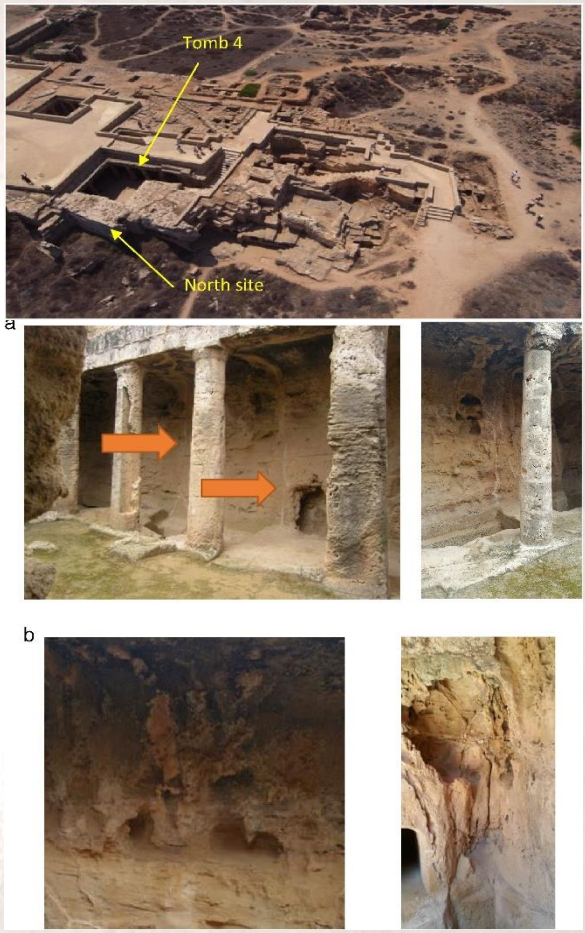
Severe and repeated earthquakes devastated Cyprus in antiquity, causing in many cases the abandonment of entire settlement sites. Yet, information regarding the level of seismic activity of historical seismicity in Cyprus is very limited and does not provide the evidence to arrive at reliable conclusions relative to hazard damage parameters such as the severity or occurrence frequency of a seismic event. Thereafter, the level of risk in which these monuments are exposed is unclear leading to an increased uncertainty regarding their safeguarding from future events. The correlation between damage observed in underground ancient tombs and the historical seismic activity is investigated at the area based on in situ observations and expert opinion analysis. In addition, the current state of the tomb's structure is simulated, predicting, through a seismic scenario, the propagation of damage from future large earthquake events. Typical examples of such structures in Cyprus are the hypogea in the necropolis of the "Tombs of the Kings", located in Paphos area. Some of these monuments exhibit severe cracking of the rock-cut stone walls and evidence of collapse of vertical resisting members of skeleton structure. Paphos area is the most active seismic region in Cyprus based on the historical catalogue of events with evidence of a number of destructive earthquakes.



Images from: Kyriakides et al. (2016), Correlating damage condition with historical seismic activity in underground sepulchral monuments of Cyprus, Journal of Archaeological Science: Reports

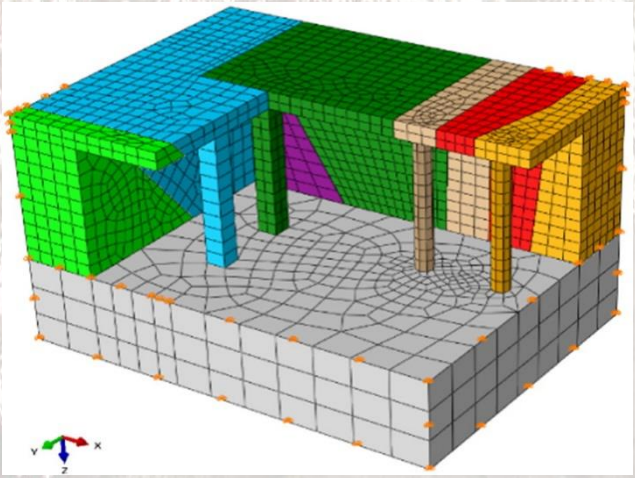


Image from: Kyriakides et al. (2016), Correlating damage condition with historical seismic activity in underground sepulchral monuments of Cyprus, Journal of Archaeological Science: Reports

The framework presented herein utilizes information regarding the current geometry of these structures as documented from topographical surveys, their depth, area of opening, size of resisting members along with information regarding the geotechnical conditions at the site to arrive at estimates of the displacement demand under various seismic scenarios. The predicted shear strain levels on the walls are compared with the strain capacity under tension of the soil material to identify the possibility of propagation of cracking of the walls based on a specific seismic scenario.

Source: Kyriakides N., Lysandrou V., Agapiou A., Illampas P., Charalambous E., 2016, Correlating damage condition with historical seismic activity in underground sepulchral monuments of Cyprus, Journal of Archaeological Science: Reports. https://doi.org/10.1016/j.jasrep.2016.07.007

Automatic damage detection from Space

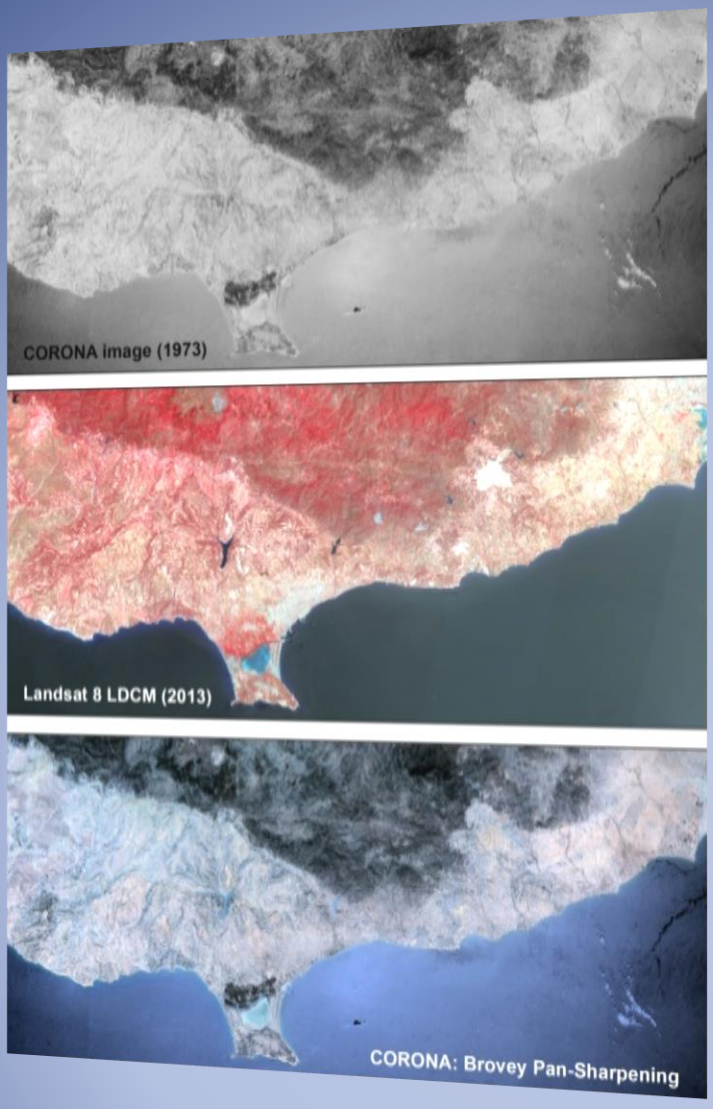


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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The intentional damage to local Cultural Heritage sites carried out in recent months by the Islamic State have received wide coverage from the media worldwide. Earth Observation data provide important information to assess this damage in such non-accessible areas, and automated image processing techniques will be needed to speed up the analysis if a fast response is desired. Some first results of applying fast and robust change detection techniques to sensitive areas are shown, based on the extraction of textural information and robust differences of brightness values related to pre- and post-disaster satellite images.

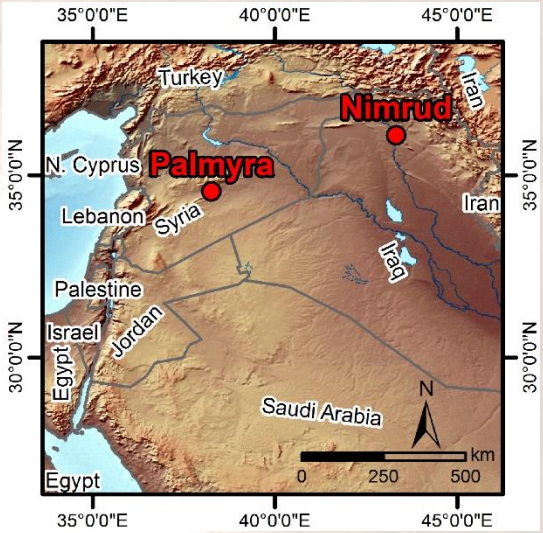
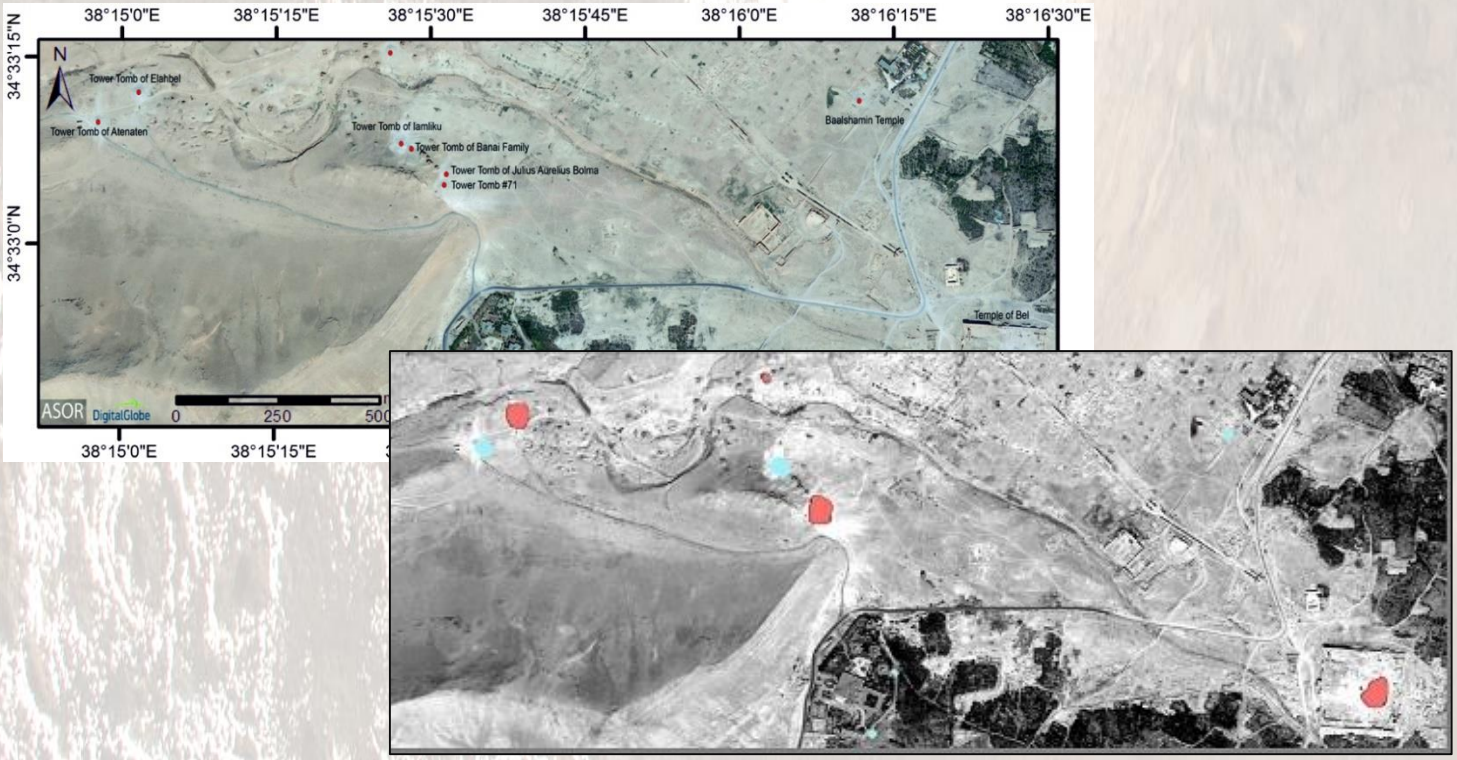


Image from: Cerra et al. (2016), Cultural Heritage Sites in Danger—Towards Automatic Damage Detection from Space. Remote Sens. 2016, 8, 781.

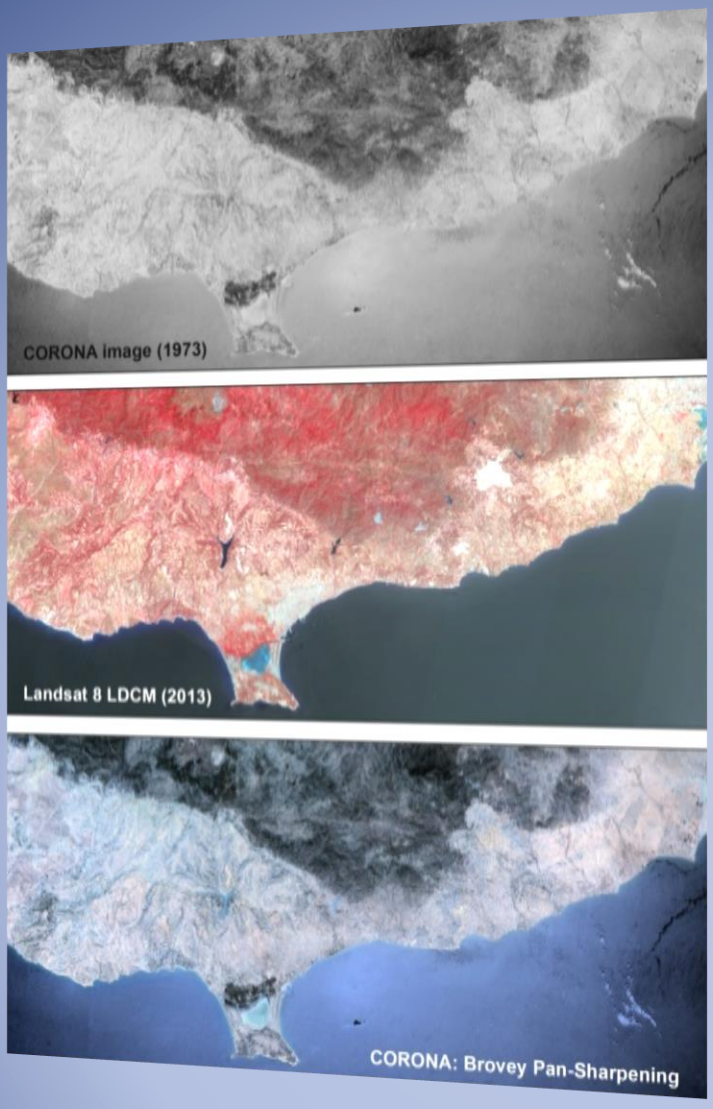


Images from: Cerra et al. (2016), Cultural Heritage Sites in Danger—Towards Automatic Damage Detection from Space. Remote Sens. 2016, 8, 781.

A map highlighting potentially damaged buildings is derived, which could help experts at timely assessing the damages to the Cultural Heritage sites of interest. Encouraging results are obtained for two archaeological sites in Syria and Iraq.

Source: Cerra, D.; Plank, S.; Lysandrou, V.; Tian, J. Cultural Heritage Sites in Danger—Towards Automatic Damage Detection from Space. Remote Sens. 2016, 8, 781. https://doi.org/10.3390/rs8090781

Detection of archaeological traces



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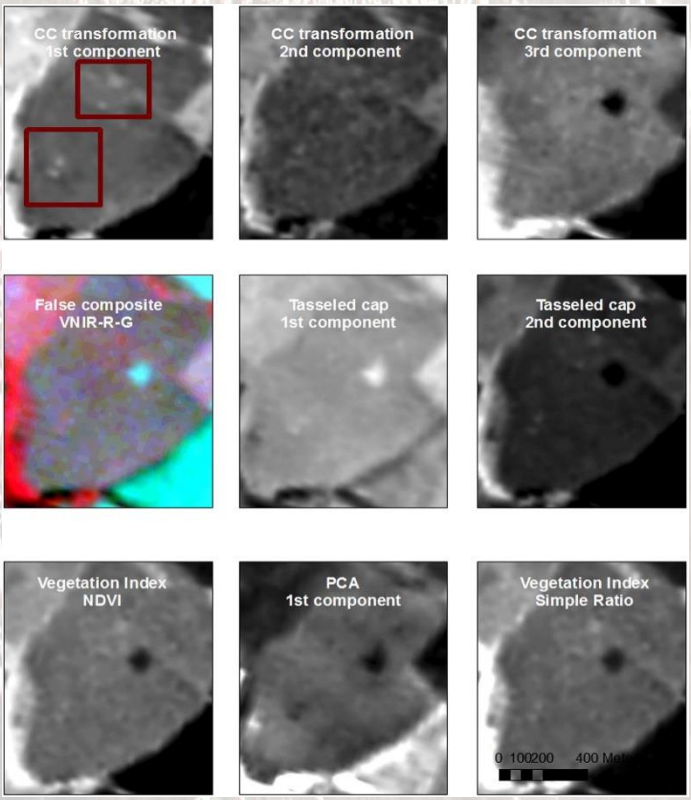
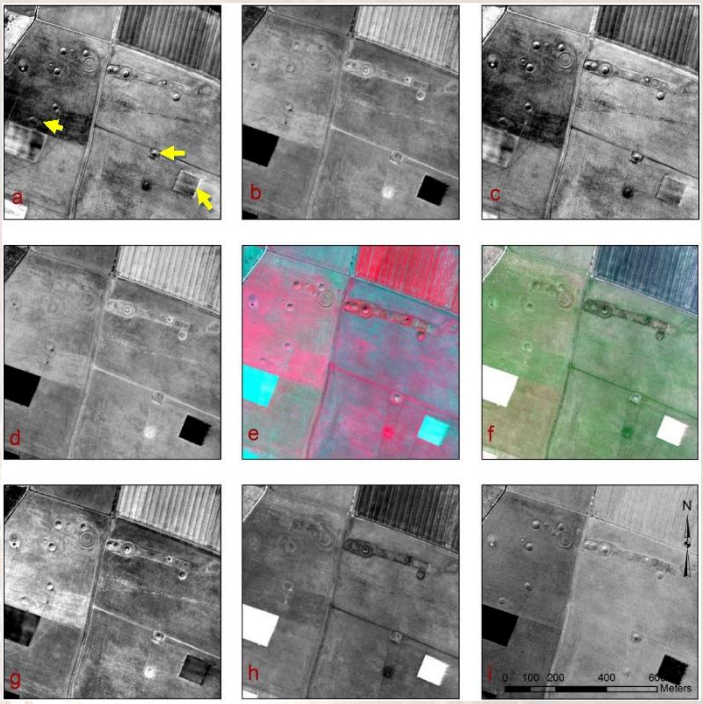
Spectral variations of vegetation, known as crop marks, have been widely used for archaeological research as a proxy to detect buried archaeological remains. Such marks can be recognized using space-borne data and image analysis techniques supported by the existing archaeological knowledge of the area under study. Orthogonal equations for the enhancement and detection of crop marks using multispectral satellite images have been recently proposed in the literature. The proposed equations are linear transformations of the initial spectral bands of multispectral datasets aiming to the improvement of the satellite images. For the calculation of the n-space coefficients of this linear transformation a four-step methodology was followed, separately for each sensor.



Images from: Agapiou (2016), Orthogonal equations for the detection of archaeological traces de-mystified, Journal of Archaeological Science: Reports

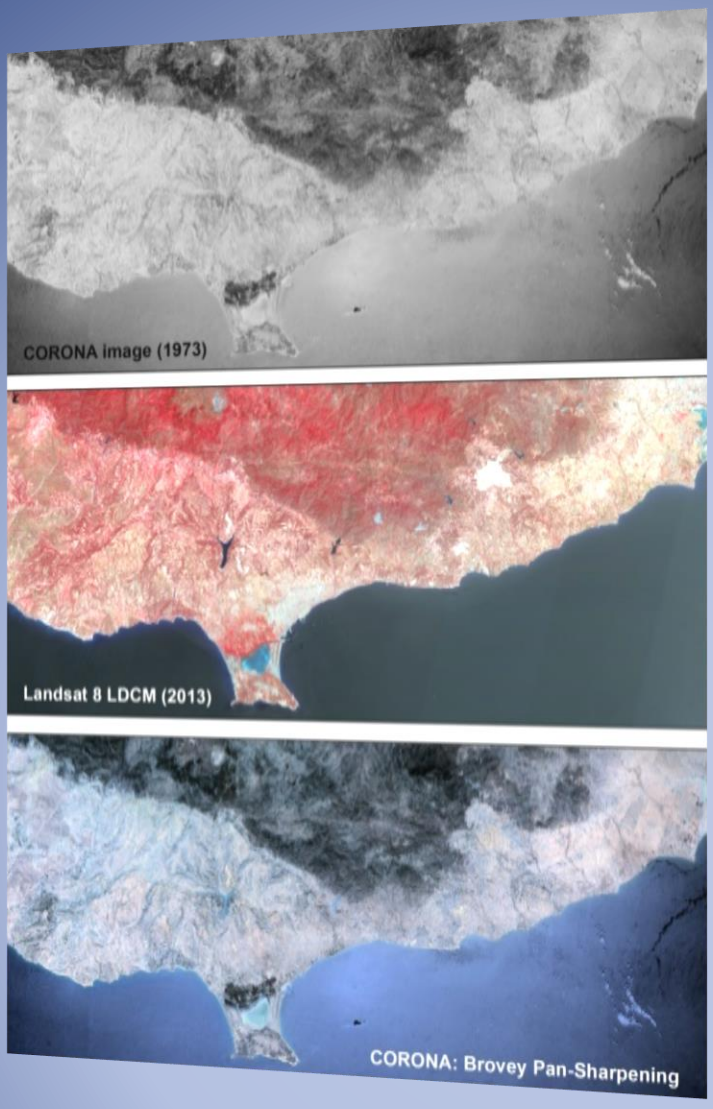


Images from: Agapiou (2016), Orthogonal equations for the detection of archaeological traces de-mystified, Journal of Archaeological Science: Reports

The fundamental concept of the development of these equations as well as some aspects related with the application and accuracy assessment are provided. Spectral characteristics of the sensor, atmospheric effects, and spectral calibration of the datasets as well as the selection of the appropriate period for applying these equations for the enhancements of crop marks are also discussed. Such orthogonal equations may be further developed and applied for any kind of sensor either hyperspectral or multispectral for the detection of buried archaeological remains. An example of the applicability of the orthogonal equations at Stonehenge archaeological site is also demonstrated.

Source: Agapiou A., 2016, Orthogonal equations for the detection of archaeological traces de-mystified, Journal of Archaeological Science: Reports. https://doi.org/10.1016/j.jasrep.2016.07.004

Spectral libraries



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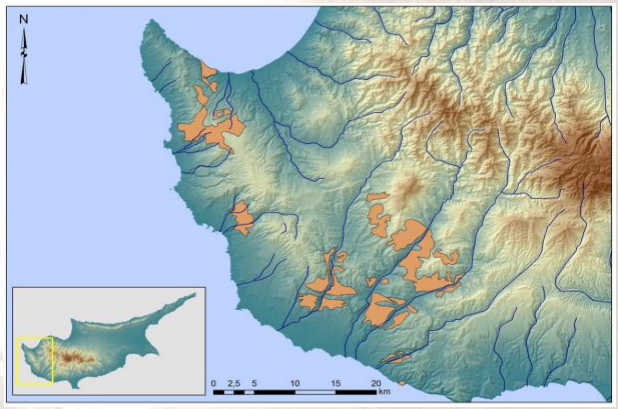
Floor mosaics are of great interest for archaeologists and art historians. While in the last decade other scientific sectors supported their study mainly from a technical point of view, through traditional archaeometric analysis, an innovative methodological approach is suggested here and some preliminary results are presented aiming to a non-destructive investigation based on the spectroradiometric analysis of stones used for manufacturing the ancient floor mosaics of Cyprus. This method evaluates the results of spectroradiometric analysis in relation to reliable destructive analysis completed in the past on the hereunder examined samples. In addition, the results of the proposed approach foresee to contribute to the expansion of the existing Cypriot database of floor mosaics, improving their characterization by collecting their spectral signatures in the range of 350–2500 nm.



Images from: Lysandrou et al. (2016), Towards a spectral library of Roman to Early Christian Cypriot floor mosaics, Journal of Archaeological Science: Reports

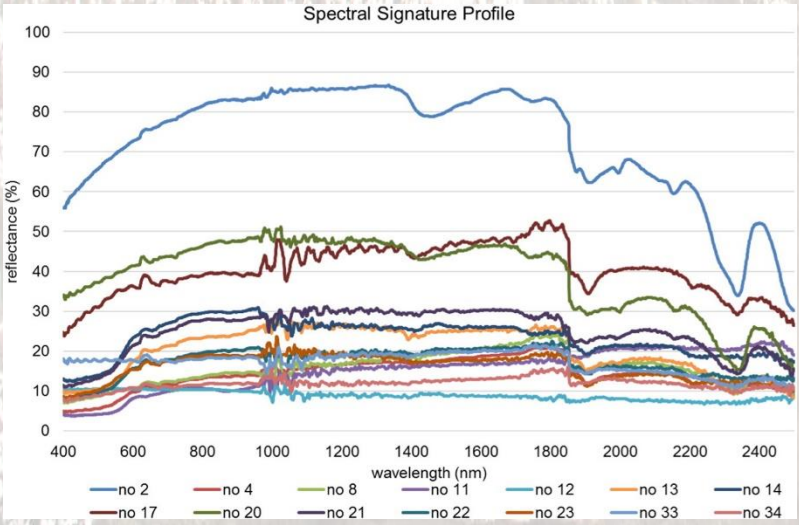


Image from: Lysandrou et al. (2016), Towards a spectral library of Roman to Early Christian Cypriot floor mosaics, Journal of Archaeological Science: Reports

The proposed methodology has been applied to a number of stone samples directly linked to pavement floor mosaic tesserae from Cyprus. The results have shown that spectroradiometers may be used in order to identify mineralogical compositions of the stones with an accuracy of nearly 90%. To the best of our knowledge, this is the first time that a comprehensive spectral library related to Cyprus floor mosaics is derived.

Source: Lysandrou V., Cerra D., Agapiou A., Charalambous E., Hadjimitsis D. G., 2016, Towards a spectral library of Roman to Early Christian Cypriot floor mosaics, Journal of Archaeological Science: Reports, http://dx.doi.org/10.1016/j.jasrep.2016.06.029

Use of multispectral high-resolution datasets

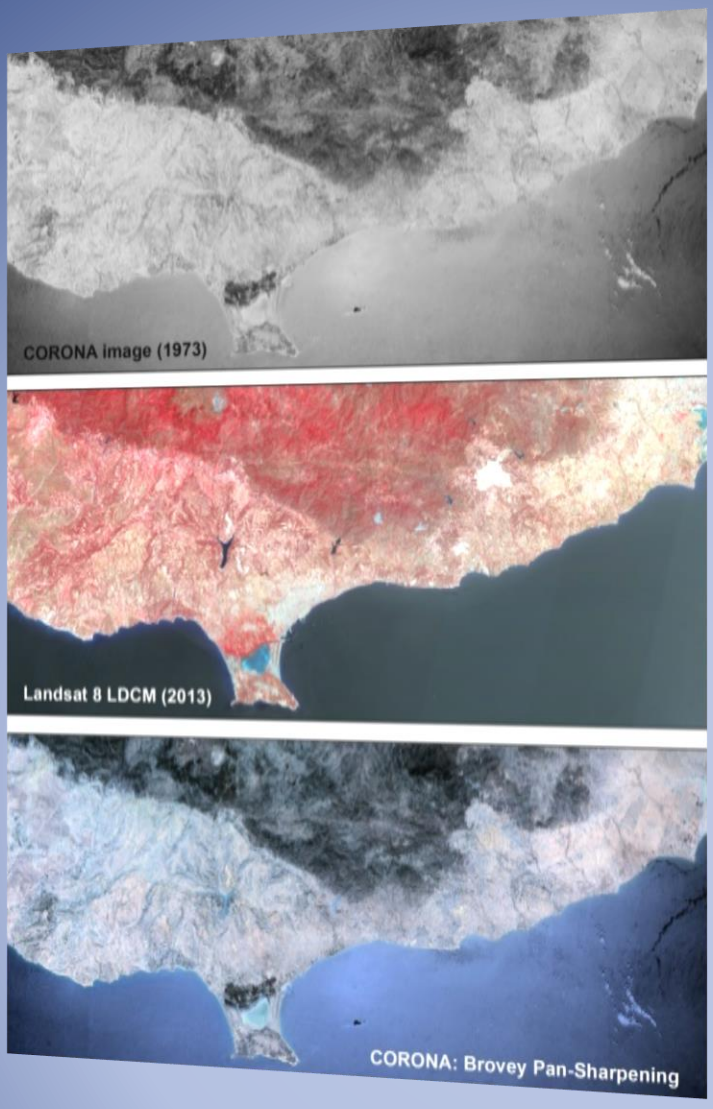


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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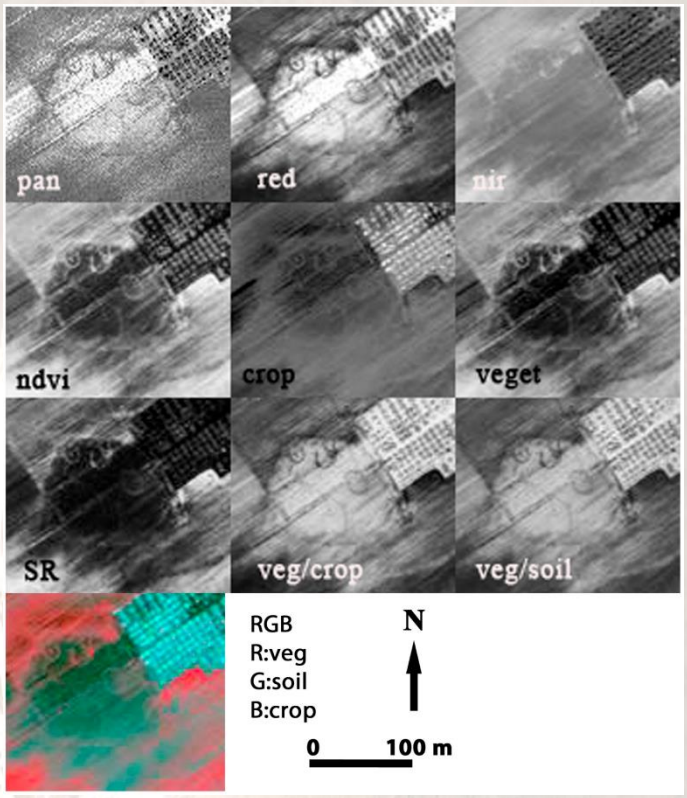
Satellite images have been systematically explored by archaeologists to detect crop marks, which are considered as a proxy for the identification of buried archaeological remains. Even though several existing algorithms are frequently applied, such as histogram enhancements and vegetation indices, the detection of crop marks still remains a difficult task, while the final interpretation results can be very poor. Here, some of the current difficulties of "remote sensing archaeology" are presented in terms of detection and interpretation of crop marks due to the crops' phenological variations. At the same time, the presented work seeks to evaluate the recently proposed linear equations for the enhancement of crop marks, initially developed for the eastern Mediterranean region. These linear equations re-project the initial n-space spectral into a new 3D orthogonal space determined by three components: a crop mark component, a vegetation component, and a soil component.



Images from: Agapiou et al. (2016), Study of the variations of archaeological marks at Neolithic site of Lucera, Italy using multispectral high-resolution datasets, Remote Sensing, 8(9), 723

Image from: Agapiou et al. (2016), Study of the variations of archaeological marks at Neolithic site of Lucera, Italy using multispectral high-resolution datasets, Remote Sensing, 8(9), 723

For the aims of this study, the Lucera archaeological site (southern Italy), where several Neolithic trenches have been identified, was selected. QuickBird and GeoEye high-resolution satellite images were analysed, indicating that vegetation indices may mismatch some crop marks depending on the phenological stage of the vegetation cultivated in the area of the archaeological site. On the contrary, ratios from linear equations were able to spot these crop marks even in shadow areas, indicating that improvements and developments of novel methodologies and equations based on remote sensing datasets can further assist archaeological research.

Source: Agapiou A., Lysandrou V., Lasaponara R., Masini N., Hadjimitsis D. G., 2016, Study of the variations of archaeological marks at Neolithic site of Lucera, Italy using multispectral high-resolution datasets, Remote Sensing, 8(9), 723. https://doi.org/10.3390/rs8090723

Satellite Data and Heritage Earth Engine© applications

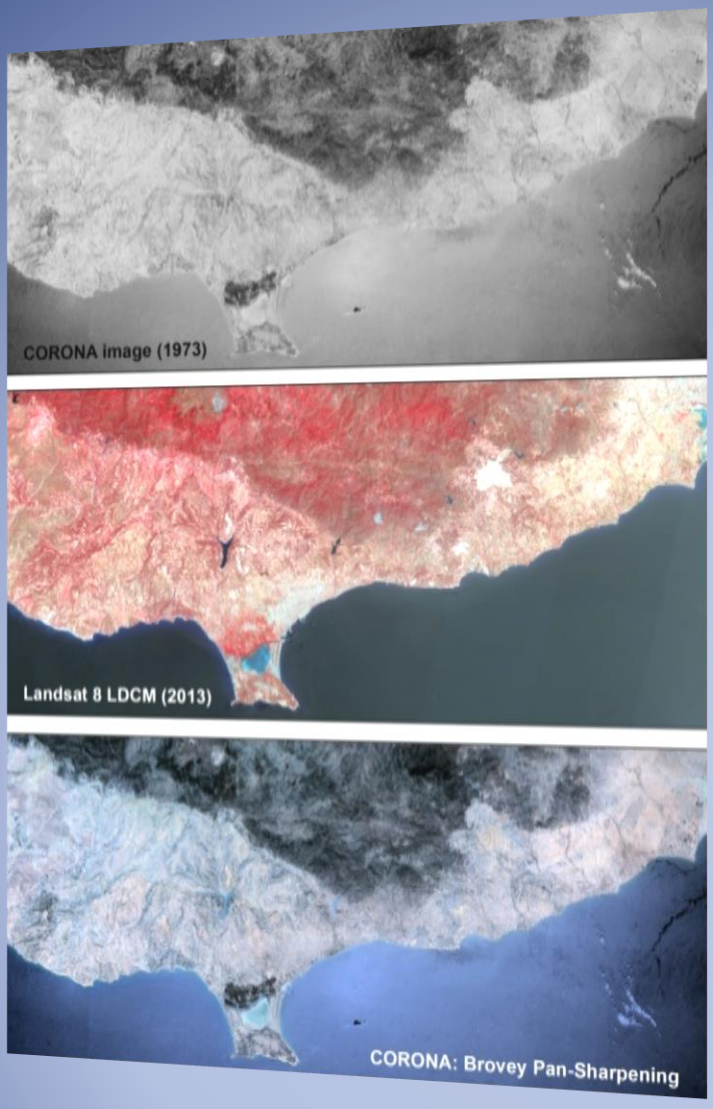


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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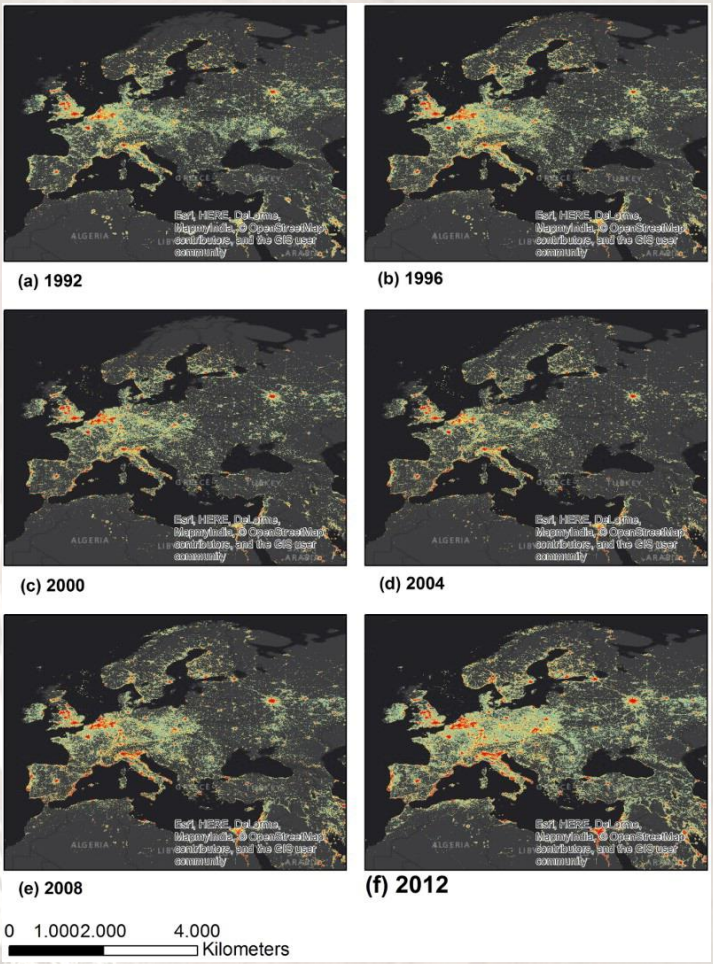
Results and considerations are demonstrated regarding the use of remote sensing big data for archaeological and Cultural Heritage management large scale applications. For this purpose, the Earth Engine© developed by Google© was exploited. Earth Engine© provides a robust and expandable cloud platform where several freely distributed remote sensing big data, such as Landsat, can be accessed, analysed and visualized. Two different applications are presented here as follows: the first one is based on the evaluation of multi-temporal Landsat series datasets for the detection of buried Neolithic tells ('magoules') in the area of Thessaly, in Greece using linear orthogonal equations. The second case exploits European scale multi-temporal DMSP-OLS Night-time Lights Time Series to visualize the impact of urban sprawl in the vicinity of UNESCO World Heritage sites and monuments.



Images from: Agapiou (2016), Remote Sensing Heritage in a petabyte-scale: Satellite Data and Heritage Earth Engine© applications, International Journal of Digital Earth

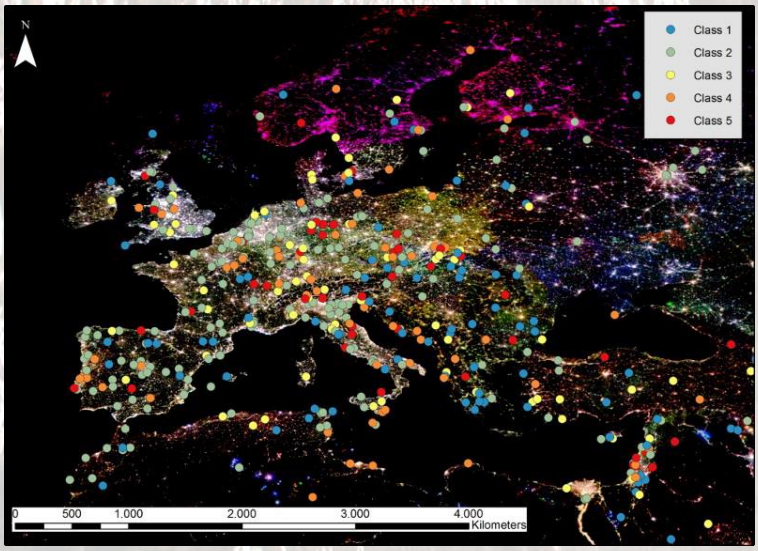


Image from: Agapiou (2016), Remote Sensing Heritage in a petabyte-scale: Satellite Data and Heritage Earth Engine© applications, International Journal of Digital Earth

Both applications highlight the considerable opportunities that big data can offer to the fields of archaeology and Cultural Heritage, while the studies also demonstrate the great challenges that still are needed to be overcome in order to make the exploitation of big data process manageable and fruitful for future applications.

Source: Agapiou A., 2016, Remote Sensing Heritage in a petabyte-scale: Satellite Data and Heritage Earth Engine© applications, International Journal of Digital Earth. https://doi.org/10.1080/17538947.2016.1250829

Remote Sensing on Archaeological Research

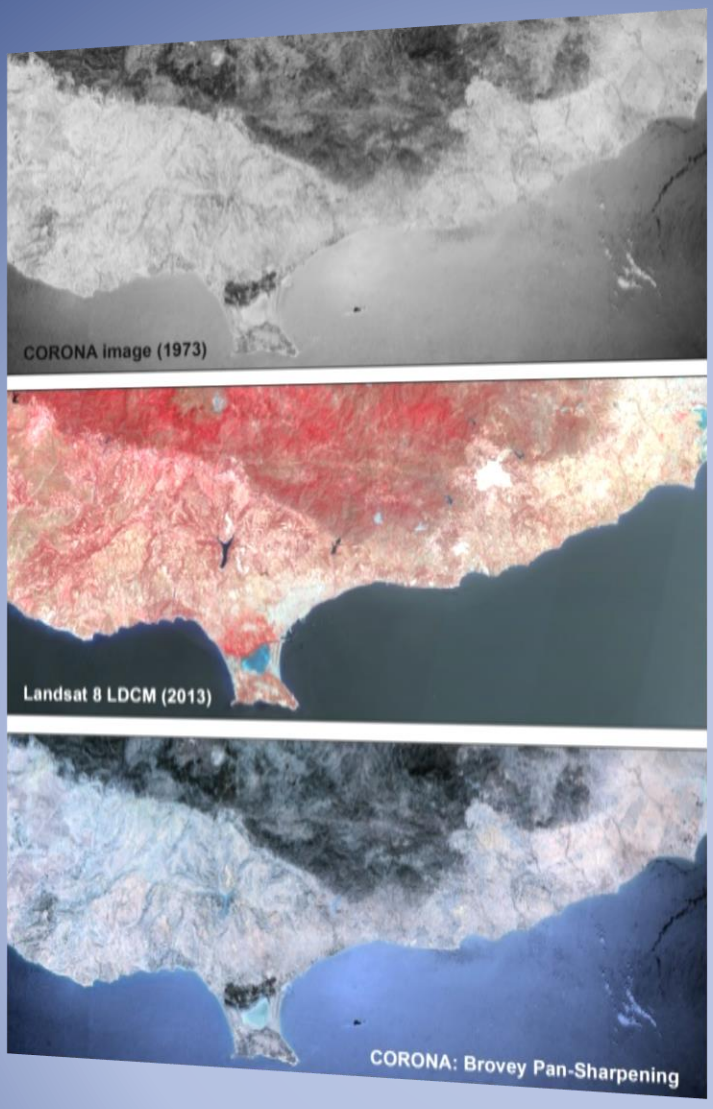


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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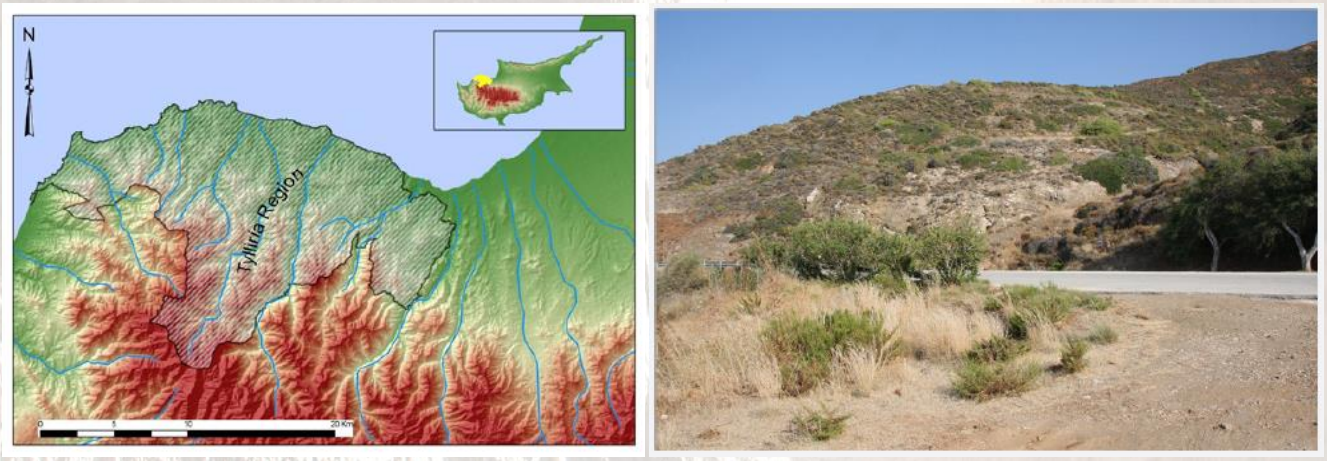
Tylliria area is situated in the north-west part of Cyprus. Its geographical territory counts several villages of Nicosia and Paphos Districts, on the basis of the modern administrative division of the island. As understood, Tylliria area holds undoubtedly an important position in the study of history and archaeology of Cyprus, boasting rich archaeological evidences still to be detected and revealed. However, this comes in contrast to the archaeological activity performed over the years in the area, which, is very limited compared to other parts of the island. Tylliria area is considered, from an archaeological point of view, one of the least studied areas on the island. The reasons for that can be briefly attributed to the modern political history of Cyprus that rendered the area not easily approached and thus isolated and distant from the main modern cities. Another obstacle in performing archaeological research is the rough geomorphology of the area that makes investigation difficult, still further time and money consuming.



Images from: Lysandrou et al. (2017), Advancing archaeological research through remote sensing: the example of Tylliria area in Cyprus, Global Journal of Archaeology & Anthropology, 1(1)

RS as a non-destructive technique can contribute to the distant investigation of an archaeological site prior, during and post excavation. Such techniques can monitor the surroundings of an archaeological heritage site by recording any modifications due to climate changes and other natural and/or anthropogenic threats and pressures. Satellite remote sensing has become a common tool of investigation and prediction of environmental change and scenarios through the development of GIS-based models to support decision-making. By blending together satellite remote sensing techniques with GIS, the monitoring process of archaeological sites can be efficiently supported in a reliable, repetitive, non-invasive, cost-effective and time efficient way. New technologies (such as radar satellite images, interferometry and other) have already been applied at various archaeological sites. New satellite sensors, such as Sentinel missions, are also expected to support archaeological research in the near future. The WordView-3 sensor with a spatial resolution of 31 cm highlights the latest achievements of space technology. Using data with such an improved quality, scientists can seek even more elaborate details for sub-surface remains and a better understanding of archaeolandscapes.

Source: Lysandrou V., Agapiou A., 2017, Advancing archaeological research through remote sensing: the example of Tylliria area in Cyprus, Global Journal of Archaeology & Anthropology, 1(1). http://dx.doi.org/10.19080/GJAA.2017.01.555551

Fusion of satellite multispectral images

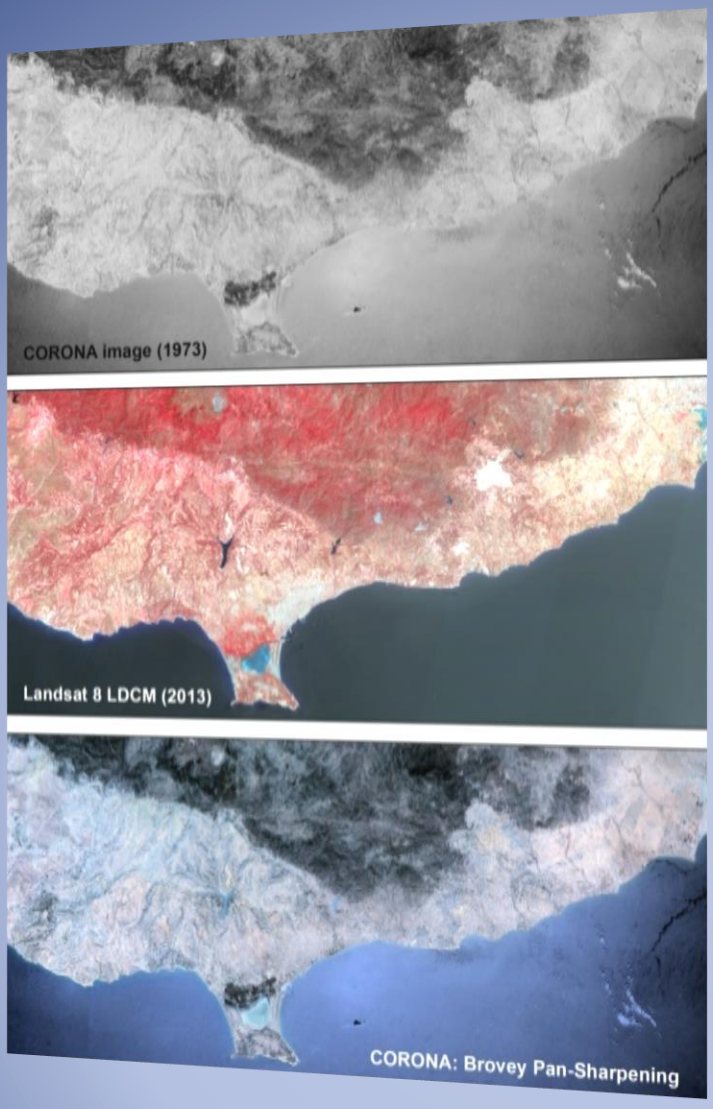


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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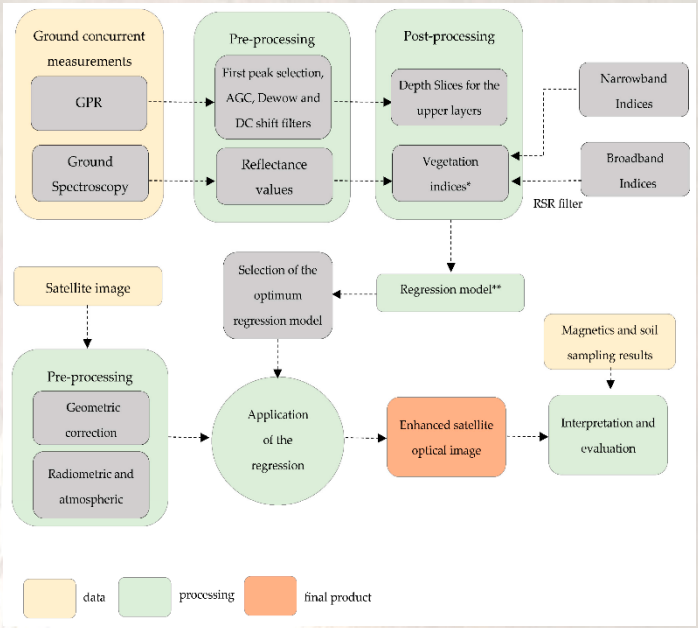
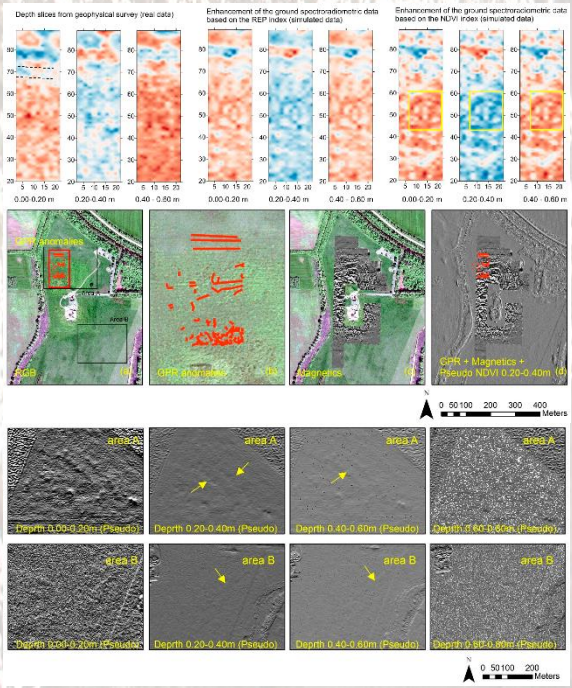
It is well known in the literature that shallow depths may be rich in archaeological remains, which generate different signal responses depending on the applied technique. In this study, three main technologies are examined, namely ground-penetrating radar (GPR), ground spectroscopy, and multispectral satellite imagery. The study aims to propose a methodology to enhance optical remote sensing satellite images, intended for archaeological research, based on the integration of ground based and satellite datasets. For this task, a regression model between the ground spectroradiometer and GPR is established which is then projected to a high resolution sub-meter optical image.



The overall methodology consists of nine steps. Beyond the acquirement of the in-situ measurements and their calibration, various regression models are examined for more than 70 different vegetation indices. The specific data analysis indicated that the red-edge position (REP) hyperspectral index was the most appropriate for developing a local fusion model between ground spectroscopy data and GPR datasets, providing comparable results with the in situ GPR measurements.



Images from: Agapiou et al. (2017), Fusion of Satellite Multispectral Images Based on Ground-Penetrating Radar (GPR) Data for the Investigation of Buried Concealed Archaeological Remains. Geosciences 2017, 7, 40.

Other vegetation indices, such as the normalized difference vegetation index (NDVI), have also been examined, providing significant correlation between the two datasets (R = 0.50). The model is then projected to a high-resolution image over the area of interest. The proposed methodology was evaluated with a series of field data collected from the Vésztő-Mágor Tell in the eastern part of Hungary. The results were compared with in situ magnetic gradiometry measurements, indicating common interpretation results. The results were also compatible with the preliminary archaeological investigations of the area. The overall outcomes document that fusion models between various types of remote sensing datasets frequently used to support archaeological research can further expand the current capabilities and applications for the detection of buried archaeological remains.

Source: Agapiou, A.; Lysandrou, V.; Sarris, A.; Papadopoulos, N.; Hadjimitsis, D.G. Fusion of Satellite Multispectral Images Based on Ground-Penetrating Radar (GPR) Data for the Investigation of Buried Concealed Archaeological Remains. Geosciences 2017, 7, 40. https://doi.org/10.3390/geosciences7020040

Integrated investigation of built Heritage monuments

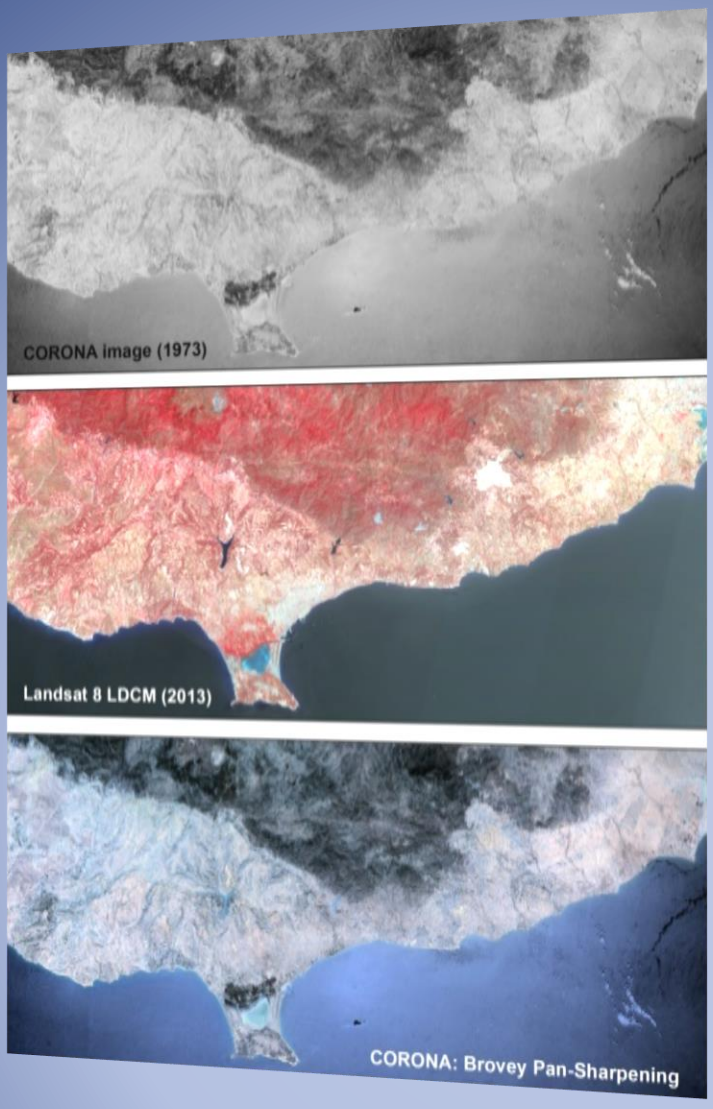


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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The state of preservation of built heritage monuments is often evaluated by means of several destructive techniques, which are mainly focused on the analysis of small parts of the monuments' construction materials. The necessary sampling for the accomplishment of these destructive analyses is usually restricted to confined parts of a monument, since monuments are usually under protective legislation, and therefore only indicative of larger areas. Current research attempts to enhance the results of provided by destructive methods, using non-destructive image processing techniques. Towards this end, the potential use of image processing based on rectified images is examined, along with material sampling and laboratory analyses as part of a multi-disciplinary methodology for the investigation of Paphos (Cyprus) Harbour Castle.

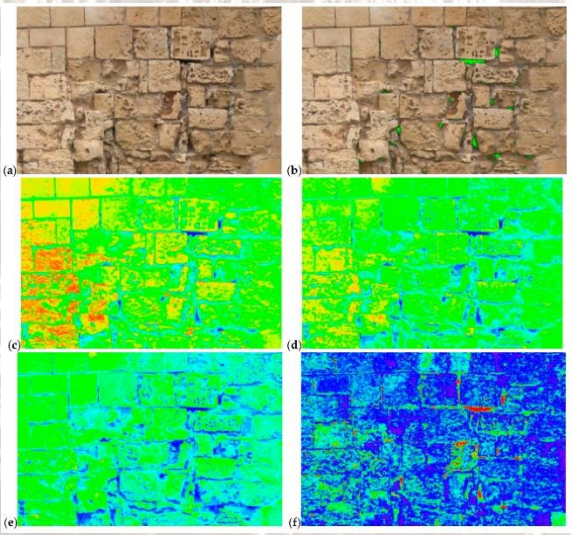
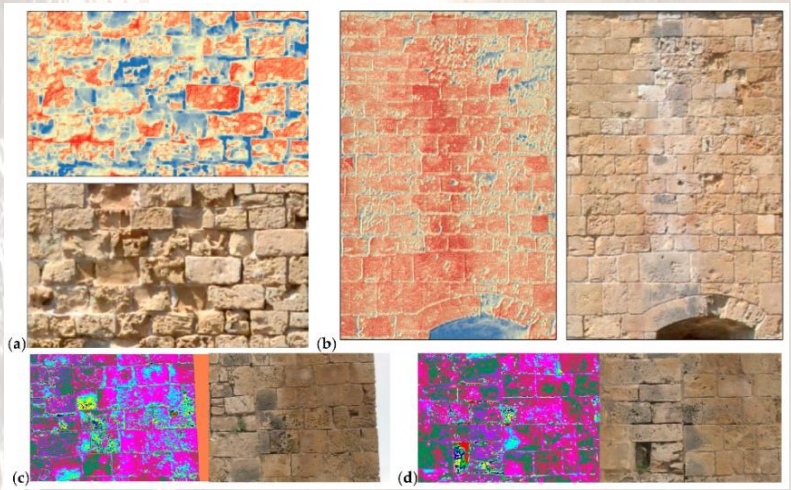


Image from: Lysandrou et al. (2018), Integrated Investigation of Built Heritage Monuments: The Case Study of Paphos Harbour Castle, Cyprus. Heritage 2018, 1, 1-14



Images from: Lysandrou et al. (2018), Integrated Investigation of Built Heritage Monuments: The Case Study of Paphos Harbour Castle, Cyprus. Heritage 2018, 1, 1-14

This approach has been adopted in order to map the degradation patterns observed on the monument's masonry walls, minimizing destructive methods and attempting to visualize the results of the monument as a whole. The combination of both analytical and non-destructive techniques resulted in the acquisition of large amounts of information, permitting the evaluation of applied non-destructive techniques for the study of the deterioration present on a monument's external surfaces. This approach led to the assessment of the overall state of preservation of the masonry walls of the structure in an extended scale covering all external facades in a semi-automatic way.

Source: Lysandrou, V.; Agapiou, A.; Ioannides, M.; Kantiranis, N.; Charalambous, E.; Hadjimitsis, D. Integrated Investigation of Built Heritage Monuments: The Case Study of Paphos Harbour Castle, Cyprus. Heritage 2018, 1, 1-14. https://doi.org/10.3390/heritage1010001

Digital documentation of Cultural Heritage

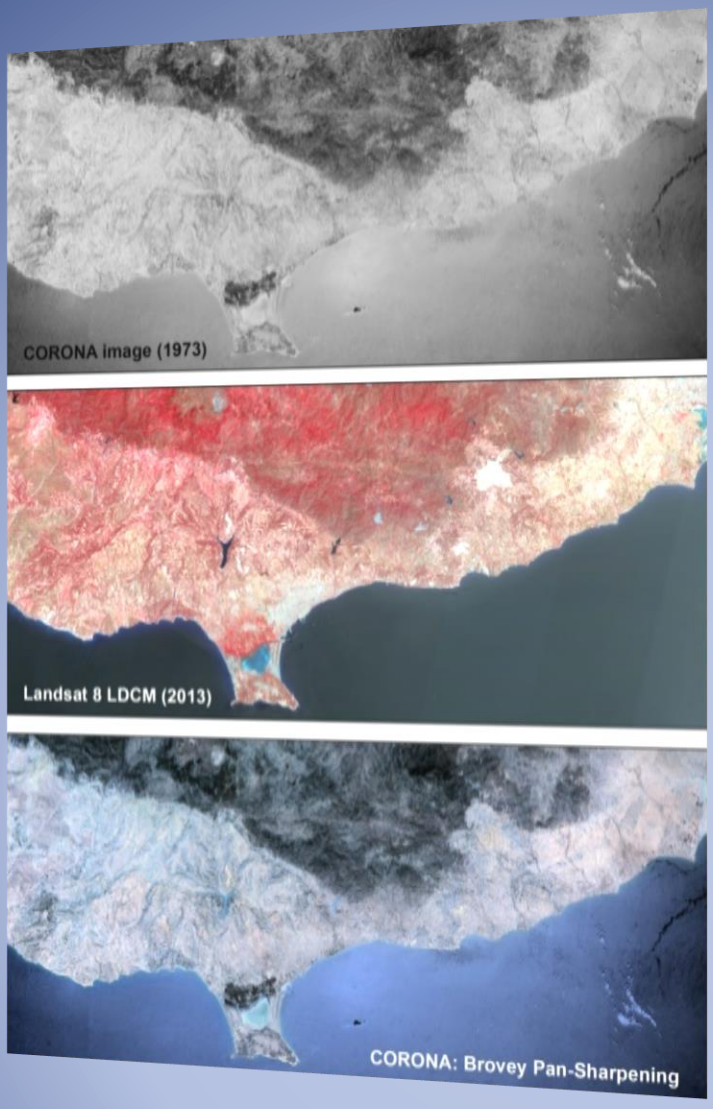


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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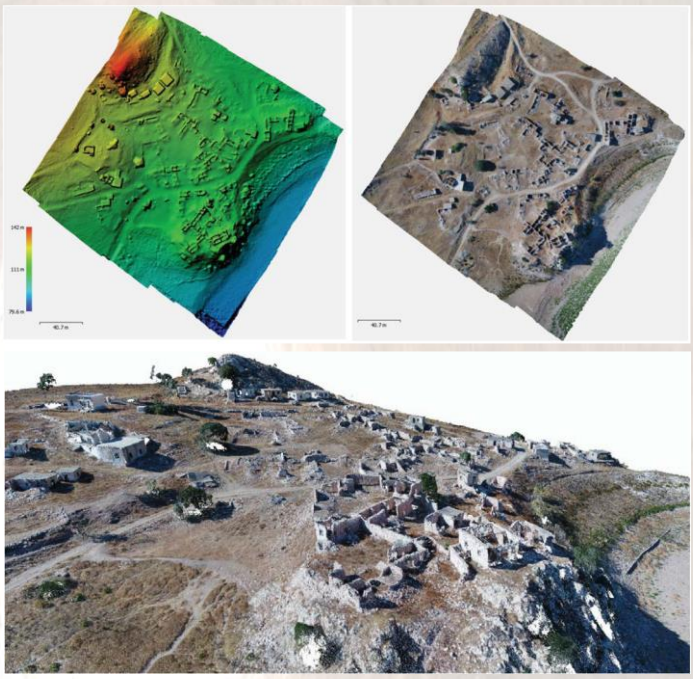
The use of traditional photogrammetry and LIDAR for documenting cultural heritage site was investigated. The case study area was Foinikas village, in the Limassol district of Cyprus, which dates back to the 11th century and has been abandoned from 1960, following the construction of the nearby Asprokremmos dam. Traditionally, photogrammetry has been used for documentation, by processing aerial images acquired from UAVs. However, with the recent development of new lightweight LiDAR scanners, it is now possible to mount professional grade LiDAR sensors on UAVs, which can be used to document areas with high accuracy. In this study, the abandoned village of Fionikas was documented using both photogrammetry using an RGB camera and a LiDAR scanner attached to a UAV. The results of the study found that both methods used provided high accuracy in the documentation of the site.



Images from: Themistocleous. "Digitization issues in documenting cultural heritage with drones: case study of Foinikas, Cyprus", Proc. SPIE 10790, Earth Resources and Environmental Remote Sensing/GIS Applications IX

Images from: Themistocleous et al. "The innovative documentation of cultural heritage using H-BIM: case study of Asinou church", Proc. SPIE 10790, Earth Resources and Environmental Remote Sensing/GIS Applications IX

Digital techniques for data acquisition and methodologies for data processing were also examined at Asinou Church as a case study. Asinou Church is a 11th century shrine to the Virgin Mary, located in the Troodos Mountains of Cyprus and is a UNESCO World Heritage Site and contains some of the finest Byzantine wall paintings in Cyprus which date between the 12th to the 17th century. Different techniques, such as photogrammetry, laser scanning, drones, video and photographs were used for the data acquisition of all features of the church, which were then processed to create a 3D model and document the church using Building Information Modeling (BIM). The church was digitally reconstructed in a 3D BIM model, where it was then processed to produce a Heritage building Information Model (H-BIM) in order to create an information database for further study.

Source: 1) Kyriacos Themistocleous. "Digitization issues in documenting cultural heritage with drones: case study of Foinikas, Cyprus", Proc. SPIE 10790, Earth Resources and Environmental Remote Sensing/GIS Applications IX, 107900B (9 October 2018); https://doi.org/10.1117/12.2325459

2) Kyriacos Themistocleous, Marinos Ioannides, Simos Georgiou, Diofantos Hadjimitsis. "The innovative documentation of cultural heritage using H-BIM: case study of Asinou church", Proc. SPIE 10790, Earth Resources and Environmental Remote Sensing/GIS Applications IX, 1079008 (9 October 2018); https://doi.org/10.1117/12.2325453

Consortium:

- Cyprus University of Technology (CY)
- National Research Council (IT)
- German Aerospace Centre (DE)

Experience of the ATHENA Project for Cultural Heritage in the East Med region

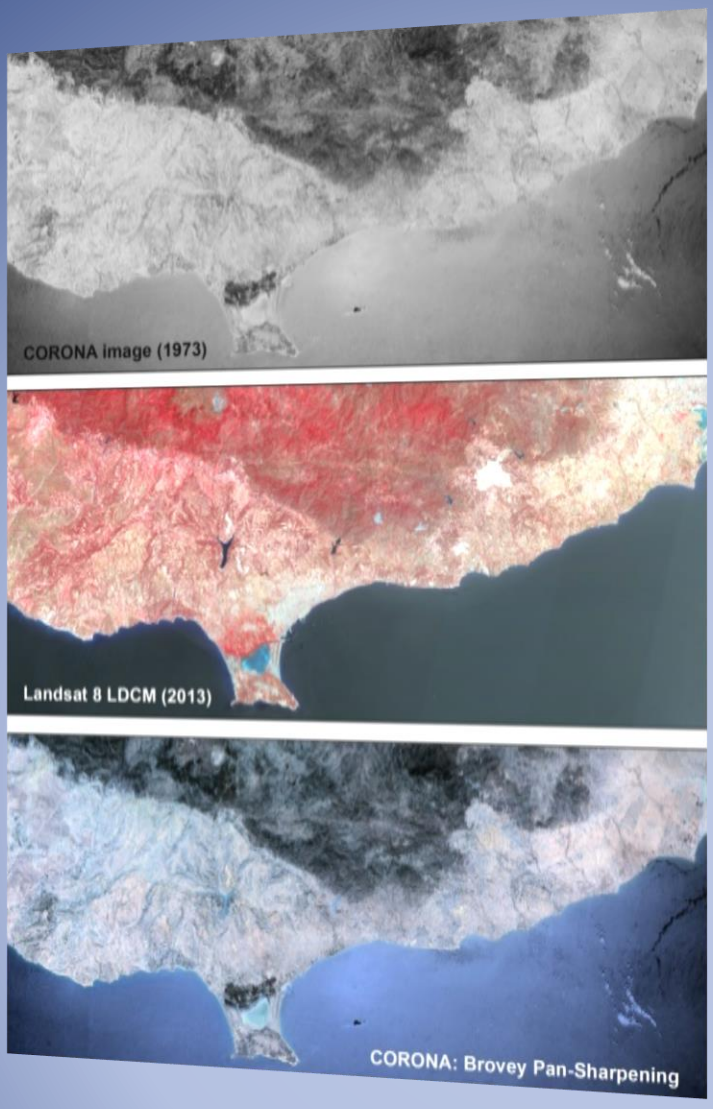


Image from: Agapiou et al. (2015), Colour to grayscale pixels: Re-seeing grayscale archived aerial photographs and declassified satellite CORONA images based on image fusion techniques, Archaeological Prospection

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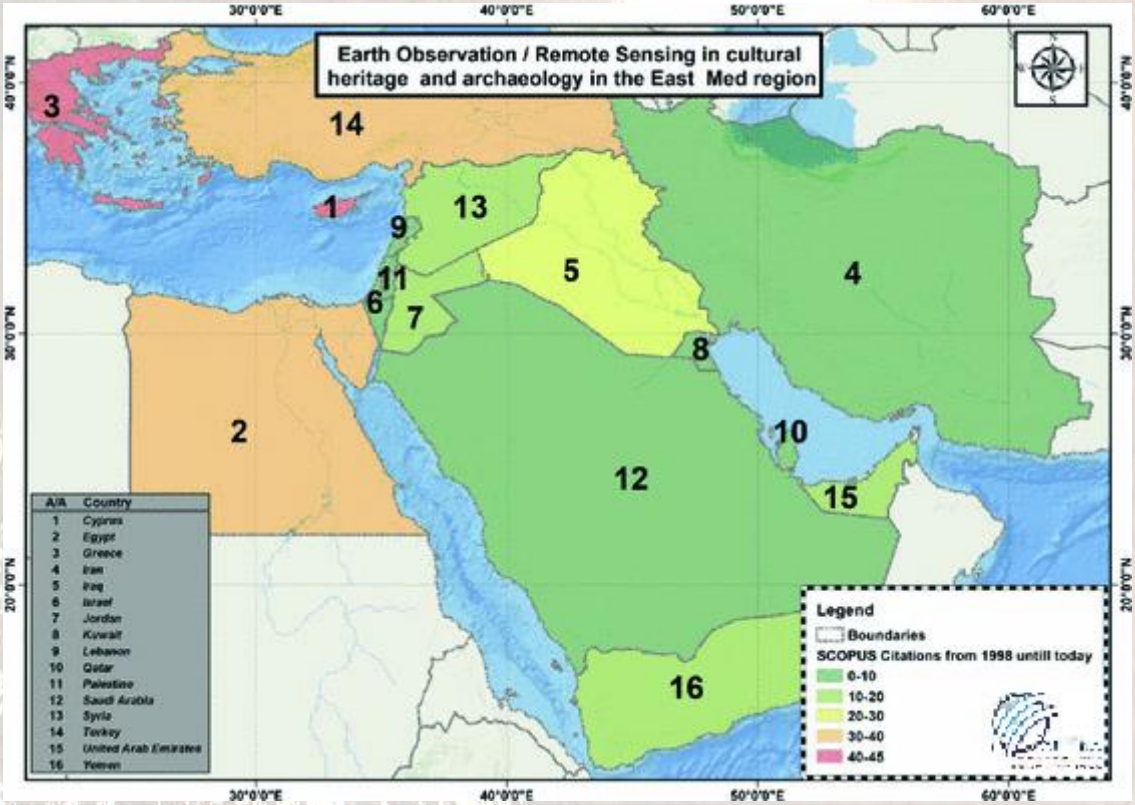
The “ATHENA” H2020 Twinning project seeks to establish a Center of Excellence in the field of Remote Sensing for Cultural Heritage through the development of an enhanced knowledge base and innovative methods in the areas of Archaeology and Cultural Heritage. An overview of the ATHENA twinning project as well a review of the remote sensing in archaeology are presented here. The ATHENA stakeholder hub is presented through a WEBGIS platform. The importance of capitalizing on the experience of running the ATHENA project for the benefit of the ERATOSTHENES Centre of Excellence (ECoE) is explained.



Research activity in the East-MED region from 1998–2018 using Scopus engine (citations). Image from: Hadjimitsis D.G. et al. (2018) Capitalize on the Experience of the ATHENA Project for Cultural Heritage for the Eratosthenes Centre of Excellence for the Benefit of the East Med Region

In recent years, Earth Observation (EO) techniques have been used extensively for archaeological and cultural heritage applications, which makes the ECoE a key player in EO activities in the Eastern Mediterranean region. The different areas that are under the umbrella of the remote sensing in archaeology sector are categorized based on the review findings. Finally, how Earth observation and remote sensing is spread out through research activities in the Eastern Mediterranean region from 1998 to 2018 is presented based on the Scopus engine.

Source: Hadjimitsis D.G., Kyriacos Themistocleous K., Evagorou E., Michaelides S., Christofe A., Nisantzi A., Neocleous K., Papoutsa C., Mettas C., Tzouvaras M., Loulli E., Kouta G., Danezis C., Lasaponara R., Masini N., Cerra D., Schreier G. and Papadavid G. (2018) Capitalize on the Experience of the ATHENA Project for Cultural Heritage for the Eratosthenes Centre of Excellence for the Benefit of the East Med Region. In: Ioannides M. et al. (eds) Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection. EuroMed 2018. Lecture Notes in Computer Science, vol 11196. Springer, Cham. https://doi.org/10.1007/978-3-030-01762-0_56