



New Tools for Probing Ancient Cypriot Architecture and Landscape

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NEW TOOLS FOR PROBING ANCIENT CYPRIOT ARCHITECTURE AND LANDSCAPE

Archaeology provides a lens through which we can learn about cultures of the past. It can involve approaches from the fields of engineering and humanities. New advances in image processing allow fascinating new insights to be gleaned from archived aerial images, and studies of both new and ancient seismic events are giving us a new understanding of the ancient world and how to preserve what remains. **Dr Athos Agapiou**, **Dr Vasiliki Lysandrou**, and **Dr Nicholas Kyriakides**, all from the Cyprus University of Technology, are embracing this blend of scientific fields in Cyprus in their fascinating investigations of ancient tombs.

Finding, Understanding, and Preserving Archaeological Sites

Understanding and preserving the past is a complex and demanding task. Archaeology is about far more than digging trenches, hoping to unearth treasures. Before any excavation can begin, promising sites must first be located and catalogued, and the surrounding geology must be studied and understood. Once excavation has been completed, the question then remains of how best to protect and preserve what was uncovered.

To tackle some of these challenges, Dr Athos Agapiou, Dr Vasiliki Lysandrou, and Dr Nicholas Kyriakides from the Cyprus University of Technology are utilising a range of techniques to find, understand, and preserve archaeological sites. Drawing on a broad and comprehensive skill set, they are investigating ways to locate ancient tombs and what seismic events they have survived.

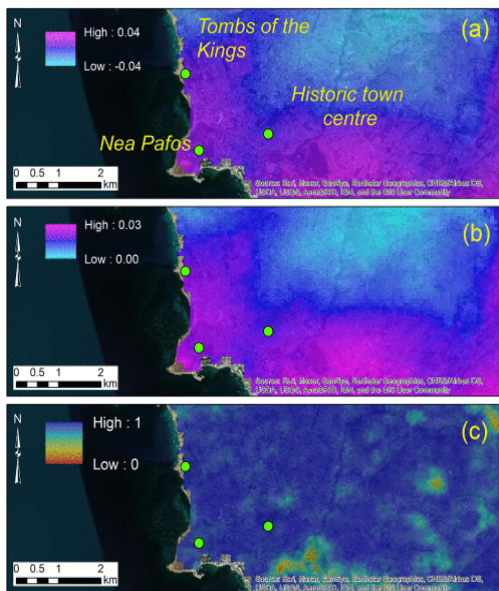
The study of these structures is incredibly useful not only from a cultural but also

a geological and historical perspective. Ancient tombs of the Hellenistic and Roman eras are underground, sturdy structures, allowing them to survive events that may have destroyed buildings on the surface. As such, they can hold vital clues to help piece together a better understanding of the culture that built them and the subsequent events that may have destroyed them.

Locating Sites of Historical Importance

The first challenge for archaeologists is locating a site of historical importance. Historical records often give hints to potential locations, and specially chartered aerial surveys can search large areas looking for tell-tale clues. However, in areas where these surveys have not been undertaken and records are patchy, this process can be difficult.

Cyprus has not had a dedicated archaeological aerial survey, so Dr Lysandrou and Dr Agapiou turned to photographs taken as part of the Department of Lands and Surveys land management surveys. These



Credit: Athos Agapiou

photographs were not designed to be used to find buried ruins, but through careful analysis, Dr Lysandrou and Agapiou hope to identify surface features indicative of buried tombs and other monuments.

Dr Lysandrou and Agapiou used aerial photographs of an ancient burial ground cemetery in Nea Pafos. Whilst the site was excavated in the 1980s, a photo from 1960 showed the site long before excavation began. This makes it the perfect site to analyse photographs to identify surface features corresponding to buried architecture. To begin their analysis, they used a series of programs to digitise, filter, orient, and enhance the photo. This allowed them to fit the photo to existing digital terrain scans and highlight the features they hoped to find.

After this process, Dr Lysandrou and Agapiou started to map out archaeological markers on the photo with the location of the tombs they knew lay just beneath the surface. With a set of surface markers, they then ran programmes that detected repeating shapes and found archaeological markers in places that had not yet been excavated, hinting that there may be more to uncover in the area. Whilst the programmes struggled in areas where there was denser vegetation, this method was able to reveal a wealth of

information from a photograph that was not deliberately taken for archaeological purposes. Excitingly, this suggested that by digitising and scanning other aerial archives, completely new sites could be unearthed.

Earthquakes and Sites of Archaeological Importance

Earthquakes can be hugely destructive, and in a seismically active area such as Cyprus, it is important to assess the risk of a seismic event occurring at sites of archaeological importance. To achieve this, researchers are turning to ancient tombs to study the frequency and severity of earthquakes in antiquity.

Dr Kyriakides, Dr Lysandrou and Dr Agapiou have been studying the damage to ancient tombs from earthquakes to try and work out how at risk these sites are from future seismic events. The first challenge was to use the construction methods, geometry, and depth of the tombs to determine their resistance to seismic events. This involved careful measurement of the tombs and mapping the cracking patterns in the walls. Using these measurements, the tomb geometry was loaded into a digital environment along with data on the surrounding geology to use as the basis for a computer algorithm to test its ability to withstand earthquakes.

Using these simulations, the team was able to calculate the seismic events these tombs would be most vulnerable to, and which would cause the pattern of cracks seen in the walls. From this, they could then calculate the seismic events these tombs had been subjected to, and work out a rough idea of how frequently damaging earthquakes occurred. These simulations also gave an idea of which sorts of events caused the most damage, and how. This allows professionals in conservation to decide the appropriate measures to be taken to effectively protect the tombs in future seismic events.

Dr Agapiou and Dr Lysandrou have also been working on data gathered on more modern earthquakes. By studying satellite data of areas of archaeological interest, they have been able to see the impact that an earthquake has on a given area. Previously, the analysis of this data would have taken a long time, but with new advances in cloud-based computing, researchers are quickly able to analyse the data for any damage to the site. Additionally, as the number of satellites capable of gathering this data increases, researchers can quickly gather and analyse data on a specific site soon after an earthquake. This allows the quick assessment of any potential damage to a site without having to make the physical journey to what may be a remote and difficult to reach location, although the team does say that this cannot replace in-person inspection of any potential damage.

Employing these aerial and satellite methods, Drs Agapiou, Lysandrou, and Kyriakides have been able to uncover a wealth of information about the funerary architectures lurking beneath the surface of Cyprus. Using this information, they can find, monitor the health of, and suggest protection measures for structures that have been lost for thousands of years. Their exciting work is paving the way for the protection and preservation of these important historic sites for generations to come.

Meet the Researchers



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Dr Athos Agapiou gained his PhD in Remote Sensing Archaeology from the Cyprus University of Technology in 2013. His current research interests are focused on Earth Observation and Geoinformatics in relation to archaeology. In 2018, he received the internationally recognised Young Researcher Award at the Cyprus Research Awards. He has also been awarded numerous scholarships from prestigious organisations, including the Alexandros S. Onassis Foundation, the Greek State Scholarship Foundation, and the Technical Chamber of Greece. In 2022, he became Deputy Director of the UNESCO Chair of Digital Cultural Heritage. In this position, Dr Agapiou aims to advance the field of digital cultural heritage while also working to digitally archive and preserve historical artefacts and landmarks.

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Dr Vasiliki Lysandrou was awarded her PhD in Mediterranean Archaeology from the University of Cyprus. With a particular interest in funerary architecture and monument restoration and preservation, Dr Lysandrou's work bridges the gap between engineering and humanities, using computational methods in the field of cultural heritage. This includes the processing of archived aerial photographs to geolocate unpublished and undiscovered Hellenistic tombs, using satellite images, space-based sensing, and geospatial tools for coastal archaeology, and the analysis of commercially available digital media to assess cultural landscapes.

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Dr Nicholas Kyriakides gained his PhD from the University of Sheffield in the Seismic Risk Assessment of Reinforced Concrete (RC) Buildings. Dr Kyriakides's research looks at the potential for damage in RC structures caused by seismic activity and how to repair a building after a seismic event or, even better, strengthen it beforehand. He has been studying how to retrofit buildings with modern materials to improve their strength, and the addition of materials to concrete (for example, recycled rubber from tyres) to improve energy absorption. He is currently head of the laboratory for Structural Assessment and CoAssessment and Concrete Construction Innovations at the Cyprus University of Technology, and served as Vice President for the Central Board of Directors of the Cyprus Association of Civil Engineers.

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