Title:

AncientCity: A new Frontier in Ancient Greek Urbanization through Geoinformatics

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Abstract

AncientCity comprises an initiative to explore new perspectives in studying the ancient Greek urbanism through modern and advanced technological tools. The understanding, reconstruction and development of ancient Greek cities is approached through an integrated protocol composed of satellite/aerial remote sensing, multicomponent geophysical prospection and spatial analysis within a Geographical Information System platform. This involved the use of digital applications to detect patterns in the ancient built environment, the identification of surface and subsurface features through non-destructive archaeological fieldwork and the creation of digitized thematic plans of ancient Greek settlements. Totally five archaeological sites from two different Greek geographical regions (central Greece and Peloponnese) were chosen to incorporate new urban models and recalibrate the traditional narratives about the development of the Greek city. The encouraging results of this integrated approach can be used as a prototype model for the employment of Geoinformatics in the historical and archaeological sciences within the subfield of Mediterranean archaeology.

Main Objectives

New Aspects
Introduction

The understanding of the ancient Greek city is diachronically altered based on the source material and the changing methodological approaches. The large scale excavations in Miletus, Pergamon, Corinth, Delphes, Corinth and Athens (known as “Big Digs”) of the late nineteenth and early twentieth century by foreign archaeological schools and local archaeological societies in the Eastern Mediterranean contributed a wealth of information regarding the ancient Greek built environment. Hidden street systems, fortification walls and gates, monumental architecture, public and commercial venues were all revealed within a singular urban context (Shanks 1996). A significant diverse in the archaeological practice was noticed after the middle of twentieth century with a shift from large scale excavations to detailed studies of the urban environment with targeted fieldwork, a practice that continues until today (Hoepfner and Schwandner 1994; Haggis 2011). The onset of survey archaeology by studying the ancient countryside provided an important methodological push during the early 1980s (Given and Knapp 2003). At the same time several archaeological projects were oriented in the study of wider archaeological features of the Greek city (Lolos et al. 2007).

Concurrent with the above developments in archaeological research, geo-information methods, through innovative satellite, aerial and global positioning systems (GPS), improved image processing methodologies and high definition geophysical mapping techniques integrated within Geographical Information Systems (GIS) have given a new dimension in the archaeological research and the way of managing the cultural heritage (Lasaponara and Masini 2011). Multispectral satellite and airborne remote sensing imagery has provided new and important information for the discovery, delineation and analysis of archaeological areas (Giardino 2011). Geophysical prospection methods involving magnetic systems composed of multiple gradiometer sensors configured on towed platforms novel multi-channel Ground Penetrating Radar array systems (Trinks et al. 2010), electrical resistivity tomography methods (Papadopoulos et al. 2007) and multi-frequency controlled-source electromagnetics have opened new horizons for large scale archaeological prospection.

AncientCity was focused on two different regions situated in the mainland Greece including Peloponnese and Central Greece setting specific parameters for the investigated sites, their chronological timeframe (spanning from Classical to Hellenistic period) and the categories of the investigated data (e.g. architectural members from buildings, stratigraphic evidence, ancient roads, literary testimonia etc). The archaeological sample included the sites of Halos and Onchestos in Central Greece and Elis, Heraia and Mantinea in Peloponnese (Fig. 1). These settlements were not greatly impacted by modern villages and constructions, thus optimizing the benefits of geoinformatics in revealing the hidden urban network.

Methodological Flowchart

The existing historical and scientific material from previous and current archaeological fieldwork projects and their related publications were gathered in order to be with the technological applications. The available topographical plans, site maps, and the archaeological data were digitized into a GIS platform aiming to facilitate the analysis of individual sites and elucidate the wider patterns of Greek urbanism. High-resolution multispectral satellite images (QuickBird, WorldView) were used to recognize residues of the ancient built environment street systems, settlement boundaries, roads connecting the urban centers to the suburban sections of the settlements and agricultural plans.
Historical and new aerial images acquired with Remotely Piloted Aerial Systems (RAPS) were used to extensively document the sites.

Multi-Component Geophysical prospection (Fig. 2) consisting of large scale magnetic techniques using multi-sensor units moved with a cart, Ground Penetrating Radar (GPR), electrical resistance techniques and Controlled Source Electromagnetics were used to map the architectural relics and built environment existing in the upper strata (up to 2 m below the ground surface) of the archaeological sites and reconstruct multi-construction phases in deeper strata up to the depth of 6-8 m.

A suite of GIS spatial analyses including a study of the spatial attributes of the streets and monumental buildings, proximity studies, density functions, buffering, site catchment, correlations with altitude or land use, proximity to the coastline, corridors of communication, visibility, etc. were made for the different sites thus extracting environmental information regarding the settlements.

Results

In 2014 an integrated campaign of satellite remote sensing and geophysical survey at Mantinea in central Peloponnese. Mantinea was established before the middle of the 5th century BCE within a level flood basin of northeastern Arcadia. The city was destroyed by a Spartan invasion in 385 BCE and its citizens were forced to depopulate. The Spartans successfully breached the fortification walls by damming the Ophis river flowing through the town. The city played a prominent role in the activities of the newly established Arcadian League during the 4th century BCE continued to be an influential regional presence in Arcadia and the Peloponnese for several centuries. The known archaeological features at Mantinea include the well-preserved elliptical fortification walls, approximately 4 km in circumference, the agora and theater at the center. Very little of the remaining urban area inside the fortification walls (~120 hectares) has been explored. Intermittent Greek excavations from the 1960s onward uncovered some evidence for domestic structures and roads south of the agora. A geophysical survey through the use of soil resistivity and magnetic methods was conducted in late 1990s (Sarris 1992). Although the target area was limited to 1 hectare, the survey found conclusive evidence for subsurface streets arranged at right angles together with various buildings, possibly domestic in nature. Before on-site geophysical survey, a satellite remote sensing campaign was conducted using four high-resolution multispectral satellite images. The Quickbird and WorldView-2 satellite images cover a broad area of 25 sq km. Feature enhancement algorithms, including vegetation indices like NDVI, maximized the detection of subsurface structures. The specific processing procedure managed to outline an extensive system of orthogonal streets showing that the city was a planned settlement. The frequency, the ordered arrangement and the metrology of anomalies are clear, and many begin to form the outlines of long rectangles that are assumed to city-blocks (Fig. 3).
The city of Elis is located on the banks of the Peneios River near Ancient Olympia in the Peloponnese. Elis is particularly known in connection to the Olympic Games as it acted as a training base prior to competition, as overseer of the sanctuary of Zeus and the administrator of these events. The site has been the focus of archaeological investigations since 1910 when excavations were initiated by the Austrian Archaeological Institute followed by later works of the Archaeological Society of Athens and the local Ephorate of Prehistoric and Classical Antiquities. In November 2014 an extensive geophysical survey was undertaken in order to explore the urban characteristics and boundaries of the settlement beyond the agora and central region of the city. The results were successful in identifying an orthogonal street system that extends well beyond the agora complementing at the same time previous geophysical survey (Tsokas et al 2012). The street system is mainly dominated by N-S and E-W trending roads which extend at least 1km southwards from the central agora. The intersection of E-W trending roads with N-S roads are sometimes slightly offset, so that the E-W roads do not meet. This mirrors the arrangement seen at other Classical Greek cities, such as at Mantinea. In addition to the streets, geophysics also found evidence for buried architecture, possibly from domestic structures (Fig. 4). Elis can now be counted as one of the few planned classical settlements in the Peloponnese that are known to archaeologists.

According to the historical sources, Heraia was situated on the North and West side of the Alpheios river, 15 greek stadia from its tributary Ladon. From the VII century B.C. Heraia started to gain great power and it became an important city of Arcadia. Archaeological field surveys by ancient and modern travellers and some small scale excavations managed to identify scattered structural remains (Philadelfeus 1931-32). A large scale geophysical and aerial remote sensing survey was made in the wider area in order to map the urban network of the city. Low-altitude RGB aerial images were acquired with a RPAS using two to three cameras configurations. A total area of almost 20 hectares was covered with the RPAS photographs. The images, processed in photogrammetry, allowed a full
digital elevation model for the entire area and the creation of an orthophoto mosaic. The autoptic and computer-aided examination of single frames and mosaicked orthophoto allowed the identification of areas of interest, where linear features could be characterized as potential man-made buried structures. Of particular note the central eastern part of the surveyed area (Fig. 5), where linear features (made more visible with histogram color enhancement) seem to form a rectangular structure, potentially referable to a closed building of about 8x10 meters.

Conclusions

The application of novel geo-information methodologies through an integrated platform can be effectively used to address specific archaeological questions regarding the ancient greek urbanism. At the same time this initiative can act as a model for other archaeological projects across the eastern Mediterranean by incorporating new urban models in order to recalibrate the traditional narratives about the development of the Greek city.

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References