THE URBAN PLANS OF DEMETRIAS AND PHERAI IN THESSALY: AN INTEGRATED GEOPHYSICAL AND SATELLITE REMOTE SENSING FIELDWORK CAMPAIGN

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Abstract

This paper presents the results of remote sensing fieldwork at Demetrias and Pherai in Thessaly undertaken in 2014. Geophysical prospection, using new generations of multi-component equipment (multi-sensor magnetics, multi-antenna GPR, multi-frequency EM), has been used in tandem with high resolution satellite image processing to reveal an extensive network of streets, sections of city blocks, and residential and public buildings. This new and valuable information reveals much about the wider urban planning of each settlement. At Demetrias, geophysical prospection was successful in mapping the orthogonal street system around the Hellenistic palace, public buildings along the western side of the agora, and a large residential zone east of the agora. The identification of houses is a major step toward understanding the development of domestic space at Demetrias. From the structures mapped so far, houses of similar dimensions have numerous rooms along the streets and a large courtyard or garden in the back. At Pherai, a network of streets on a plateau at the city's northern edge had been identified initially though the processing of satellite images and consequently verified and complemented via a systematic geophysical campaign. At least 12 parallel streets spaced roughly equidistant from one another have been mapped. It is noteworthy that the streets are not organized in a strict orthogonal manner in the classical and Hellenistic traditions, but, instead, they have a diagonal arrangement. On a broad scale, the new evidence from Pherai has important implications on the history of Greek town planning in Thessaly during the second half of the first millennium B.C. While the organization of cities is a defining feature of Greek urban culture, few examples are known from Thessaly.

(Slide 1) In 2014 the Laboratory of Geophysical, Satellite Remote Sensing and Archaeoenvironment of the Institute for Mediterranean Studies based on Crete completed an integrated campaign of satellite remote sensing and geophysical survey at Demetrias and Pherai in Thessaly. The objective was to document the wider composition of the settlements beyond what is known from excavations. This includes the arrangement of streets and city-blocks, the makeup of buildings, and a general appreciation of the city's urban dynamics. A second, and far-reaching objective was to develop non-invasive methods for uncovering and exploring past landscapes in a timely manner by using new generations of equipment. This falls under a wider umbrella of research carried out under the KRIPIS-POLITEIA project to develop best practices in remote sensing for the study of archaeolandscapes, and more specifically Greek and Roman cities. **(Slide 2)** In 2014 we also conducted geophysics at Mantinea, Elis, and Gortyn, and satellite remote sensing at a dozen other sites. In its synthesis, we aim for a better understanding of the variable nature of cities and town planning in classical antiquity from mainland Greece. This morning, I will focus on Thessaly and highlight some of our significant findings.

(Slide 3) Before fieldwork, a remote sensing campaign was conducted using high-resolution multispectral satellite imagery. Feature enhancement filters were applied to the satellite images to maximize the detection of archaeological features buried beneath the surface. At Pherai, this method proved valuable in identifying a network of streets on the city's northwestern plateau, above modern Velestino. **(Slide 4)** Here, several diagonal streets appear as parallel anomalies in various feature enhancement filters. To be more specific, we found evidence for at least 12 north-south streets spaced 30 m from one another. There is a distinct convergence of some streets toward a common location to the north, where the fortification walls once stood. This is possibly an indication that a gate was once here. A few anomalies in the fields below the plateau may tentatively be interpreted as a continuation of the

same street system. **(Slide 5)** It is worth pointing out that satellite images from different years and seasons can produce different results. In these examples, a Quickbird from June 2009 identifies buried roads only in the northern half of the field, while a GeoEye from May 2010 shows roads only in the southern half. But used together, the two satellites are complimentary in reconstructing the subsurface road system.

We notice that the streets are not organized in a strict orthogonal manner in the classical and Hellenistic traditions, but, instead, they have a diagonal arrangement analogous to planned street systems of an earlier period, most notably at Megara Hyblaia on Sicily. Therefore, Pherai may have been planned, at least in part, with a regular arrangement of streets early in the city's history. Of course, only future fieldwork with targeted excavations can clarify the chronology. In any case, Pherai is an excellent example of the benefits of using satellite remote sensing during an initial phase of site exploration. Note, however, that satellite remote sensing does not always produce positive results. At Demetrias, a city with a known orthogonal street system, we were unable to identify any roads using the same methods.

(Slide 6) The geophysical survey was implemented to confirm and modify the findings of satellite remote sensing at Pherai, while uncovering new urban features at Demetrias. The Lab of the Institute for Mediterranean Studies has a distinct advantage in archaeological geophysics. First, we employ a multi-method, integrated approach to maximize the detection of buried features. This includes magnetics, electromagnetics (EM), ground-penetrating radar (GPR), resistivity, and electrical resistivity tomography (ERT). Second, our scope of geophysical exploration is extensive since we employ new generations of equipment that survey more surface area per day. **(Slide 7)** At Pherai and Demetrias, fieldwork was limited to 6.5 working days in March 2014, but during this time we covered 19 hectares with six people: an average of 3 hectares per day. Large area coverage using geophysics is rare even after many seasons of fieldwork. But multi-component equipment upgrades make this possible, opening up new avenues for exploring and mapping ancient cities even in their entirety.

(Slide 8) In the field, we combine geophysical techniques of rapid spatial coverage with targeted techniques to clarify subsurface features. For large area coverage we use a SENSYS Magnetometer MX, controlled by a team of two operators, and a Geophex GEM-2 EM, operated by a single person. The SENSYS consists of an array of eight fluxgate gradiometers accompanied by a GPS rover station. Flat topography and low vegetation are ideal for the SENSYS push-cart system. The EM is more mobile, and it measures both electrical conductivity and magnetic susceptibility, giving a broader picture of the subsoil. **(Slide 9)** GPR targeted smaller areas. It is generally slower in operation, but its ability to map architectural features can often be superior. The MALA GPR you see on the right is a new piece of equipment with 8 cm in-line spacing resolution that can also be towed by a quadbike for larger area coverage.

(Slide 10) Looking first at Pherai, the geophysical survey was successful in mapping the ancient street system on the northern plateau. Most streets are characterized as positive magnetic anomalies (here in white) in comparison to the surrounding soil matrix. This probably indicates that road surfaces consist of hard packed dirt with crushed tiles, pottery, and slag. **(Slide 11)** Sections of six north-south streets were identified in the plateau's northern region from magnetics. All terminate at an incomplete anomaly that either marks the location of the fortification walls or a ring road inside the walls. **(Slide 12)** In the southern half, we identified nine north-south streets and two east-west streets with magnetics. The widths of the streets range from 6-7 m. All streets found with magnetics correspond to most of the anomalies identified in satellite remote sensing. **(Slide 13)** The 30 m spacing of the streets and their diagonal orientations are characteristics that we anticipated from the satellite data. Note that satellite remote sensing identified a continuation of the street system east of the plateau, where we did not use geophysics.

The two east-west streets in the southern region were the only clear examples of crossroads; therefore, we cannot yet comment on the dimensions of city-blocks at Pherai. However, from what we observe, it seems that north-south streets were extended features. This may indicate that city-blocks were organized per strigas (i.e. elongated blocks, rather than squares), which is usually (but not always) characteristic of Archaic and classical Greek street systems. **(Slide 14)** Besides roads, many anomalies were mapped on the plateau as clusters of subsurface material between the roads. Although poorly defined in magnetics, these are likely the remains of buildings, perhaps residential. It would be beneficial to explore the region using ground-penetrating radar, which we did not use here, to obtain better clarity in the architectural details.

(Slide 15) Moving now to Demetrias, geophysics was successful in mapping sections of the ancient street system around the Hellenistic palace. The geophysical data confirm the accuracy of the

German city plan reconstructed some decades ago on the basis of small excavations and surface finds (this is the one you see in yellow on the slide). Geophysics was also helpful in identifying subsurface buildings with great clarity.

The region south of the Hellenistic palace, and immediately west of the agora, produced a dense collection of buried architectural features. **(Slide 16)** The northern group of structures, which appear clearest in GPR, have rectilinear rooms and corridors of various dimensions that appear to be from a large complex 35 m in width. Further south, magnetics detected another cluster of architectural features that are likely a continuation of the complex. Although the architectural details are not as clear, we observe that walls and rooms have similar orientations. **(Slide 17)** The location of these buildings along the western side of the agora raises the possibility that they constitute a group of buildings, commercial or civic, that provided a monumental architectural backdrop to the public square. This kind of arrangement was, of course, a common feature of Hellenistic and Roman town planning, and I note here a good parallel with the agora at Megalopolis in the Peloponnese.

(Slide 18) The region east of the agora produced arguably the most coherent results. In a soccer field, several methods of geophysical prospection were used in a complimentary way, allowing us to map the architecture in great detail. The results show that this region of Demetrias was a residential quarter close to the agora. **(Slide 19) (Slide 20)** The area is characterized by a north-south road (1) and an east-west road (2) with a dense collection of buildings inside rectangular city-blocks. At the northwest, a small section of another road (3) was mapped. The location of these roads correspond perfectly to the German city plan. The architectural details of the buildings are superbly defined in GPR. **(Slide 21)** The northern insula is characterized by a series of large structures with accompanying rooms and courtyards or gardens. We interpret (4) as a structure with at least seven rooms clustered at the west and a large open eastern zone that is probably a courtyard or garden. A similar arrangement is noted with (5), where the western side is again taken up by a collection of rooms and the eastern side by an open zone. Further south, the survey identified a third collection of rooms (7) that take up the whole width of the city-block. Here, there is no clear evidence for an open courtyard. South of the road, another dense cluster of rooms (8) faces the two roads. What appears to be a large open area (9), perhaps another courtyard, is found further south before terminating at a division wall. Only small sections of the eastern insulae were mapped, but the evidence is consistent with what we have found elsewhere: groups of rooms are built along the roadway.

(Slide 22) The overall arrangement of the architectural features beneath the soccer field recalls Hellenistic and Roman urban houses with courtyards or gardens in the back and shared partition walls between houses. We have identified two possible courtyard houses in the north, and one in the south. Rooms along the streets could be related to residential quarters, but some of them may also have functioned as commercial buildings. In this respect, we stress the proximity of this region of the city to the agora.

(Slide 23) Soccer fields apparently produce good results in geophysics, as another example next to the shoreline shows with magnetics and electromagnetics. **(Slide 24)** The major discovery here was the partial remains of a large buried structure at the northwestern corner of the field that is aligned with the city plan. The data are complementary from both magnetics and electromagnetics. The structure consists of a semicircular western half that is connected to a rectilinear complex with individual rooms. The radius of the semicircular portion of the structure is 25 m, while the length of the building as a whole is at least 45 m from east to west. The southern end of the rectilinear complex is subdivided into four rooms. The room at the west appears to have an apsidal end. North of these rooms, a large square area (courtyard?) appears in the geophysical data. This is clearly a building of considerable size and importance near the harbor of Demetrias. **(Slide 25)** Its form is most suggestive of a small theater with attached portico or a covered concert hall (odeion), although a bath complex cannot be ruled out. That the structure is aligned with the general city plan of Demetrias shows that it was imbedded into the wider urban fabric of the city.

(Slide 26) To briefly conclude, the integrated campaign of satellite remote sensing and geophysics at Demetrias and Pherai was successful in revealing the organization of urban space and the location of public and private buildings. At Pherai, there is substantial evidence, where none existed before, for the street layout of the northern region of the city. The diagonal alignment of the streets and the seemingly elongated form of city-blocks are unique characteristics that set the city apart from other known urban plans in Thessaly and on much of mainland Greece for that matter. Since planned settlements are not as widespread in the archaeological record on mainland Greece, this new evidence from Pherai is quite significant in our view. At Demetrias, the survey indicates that the orthogonal grid plan of the city had a wide impact on the spatial conception of public and private

buildings. The large structure near the harbor is 500 m away from the city center, but it shares the orientation of the city grid. We suspect that the orthogonal street system continued to the harbor, even though archaeological evidence in the intermediate zone is limited. Finally, the identification of what appears to be a residential zone beneath the first soccer field is a major step toward understanding the use and development of domestic space at Demetrias. Courtyard-type houses of similar dimensions were inserted within insulae. It will be interesting to see how future fieldwork at both cities, using the methods that we employ here, can contribute to a greater range of awareness at these important urban centers in Thessaly and redefine discourses on Greek and Roman urban practices. **(Slide 27)**