The Employment of Digital Tools in the Study of Ancient Thrace

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Abstract: *The employment of digital tools in the study of Ancient Thrace can enhance our understanding of the region. The vast volume of analog data available underscores the need for interconnected datasets via repositories. Digitizing various data types, including archaeological finds, literary works, and inscriptions, promotes scholarly collaboration. Moreover, the study of Thrace, a region rich in history and mythology, also benefits from research with GIS tools that enable quantitative analyses, study of people and object diffusion, trade networks, and landscape exploration. These technological advancements revolutionize archaeological research, potentially driving economic growth and influencing cultural policies.*

Keywords: Athena RC; repositories; Attic pottery; mythology; GIS; networks; landscape

Ключови думи: Изследователски център Athena; репозиториуми; атическа керамика; митология; ГИС; мрежи; ландшафт

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INTRODUCTION: ANCIENT THRACE GOES DIGIT

Archaeological research is a longtime procedure, despite the site or the topic of particular interest. As a discipline also has a long tradition going back a few centuries. In this investigation and study of the past (times, cultures, sites etc.) aiming at its better understanding, Archaeology has employed a great number of approaches and procedures. In reality, Archaeology has adapted and adopted the available tools and methods following the trends of the time. During the last decades digital technologies have significantly revised archaeological research and documentation methods with the study of ancient Thrace being no exception.

The employment of digital tools in the study of Ancient Thrace can significantly enhance our knowledge of the region as well as contribute to its understanding and promotion. Digital archaeology and its widely accessible outcomes not only revolutionize research but also potentially may lead to economic growth and to influence cultural policies. The various research projects and publications regarding Ancient Thrace are increasingly adopting these technologies, utilizing the latest advancements in the related fields.

The aim of this paper is to present some indicative examples of the interdisciplinary work done by the Institute of Language and Speech Processing (ILSP) regarding the study of ancient Thrace. Combining digital with traditional methods, it attempts to contribute to the production of new knowledge for the region as well as to make the outcomes of its research widely known and accessible. Three thematic areas are chosen to be briefly presented here: a) the collection and organization of the sources used (repositories) as the foundation for any study and research, b) the interdisciplinary approach chosen for the examination of a representative category of material (Attic pottery), and c) mythology as connecting link between Greece and Thrace. To those should be added the contribution of Geospatial research in archaeology (GIS).

COLLECTING AND ORGANIZING RESEARCH LITERATURE WITH DIGITAL TOOLS

The extensive scientific literature on ancient Thrace covers multiple languages, themes, and scientific fields. However, there is a significant need for comprehensive digital tools to organize, make accessible, and distribute this wealth. To address this, efforts are made to create centralized repositories of literature categorized by specific sites, periods, and topics. In these repositories, each publication tagged with keywords, facilitates targeted searches and improves accessibility. Moreover, committed to viability, these repositories are regularly updated to reflect ongoing discourse and state-of-the-art in the field.

Thus, for example, the **Archaeological Research in the North Aegean (ARENA)** repository[1] focuses on the extensive archaeological bibliography of Aegean Thrace **(Fig. 1)**, covering a period from the 8th century BC to 31 BC. Up to date, over 5,900 titles have been compiled regarding more than 540 ancient sites, thus creating a valuable bibliographical repository, with advanced search tools that allow users to easily explore the collected information. The repository also includes ancient texts, inscriptions, and educational material related to Aegean Thrace[2].

Likewise, the **Attic POttery in Thrace (AtticPOT)**[3] addressed the need for digital tools to aid the study of Attic painted pottery found in ancient Thrace. A digital repository was developed, encompassing Attic pottery and specialized literature, cataloging approximately 8,700 references about 215 ancient sites. AtticPOT offers researchers resources on the distribution and significance of Attic pottery in the region, providing digital tools that allow users to navigate and extract information, enhancing the

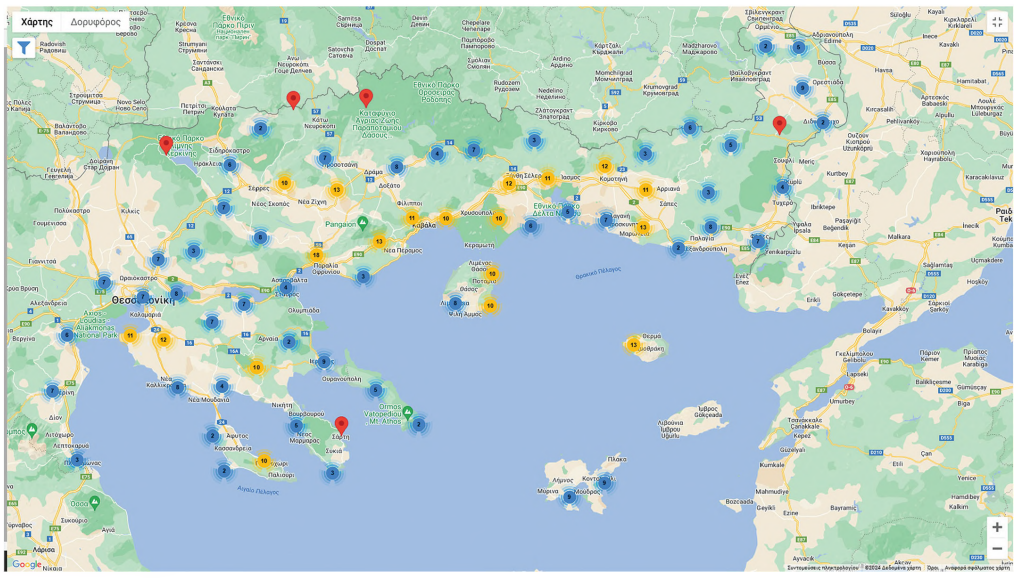

Figure 1. The interactive map of ARENA project.

[1] http://arena.athenarc.gr/
[2] *Tsiafaki and Michailidou* 2019; *Michailidou, Evangelidis and Tsiafaki* 2020; *Tsiafaki et al.* 2020.
[3] https://atticpot.athenarc.gr/index.php/en/; https://atticpot.athenarc.gr/repo/en/

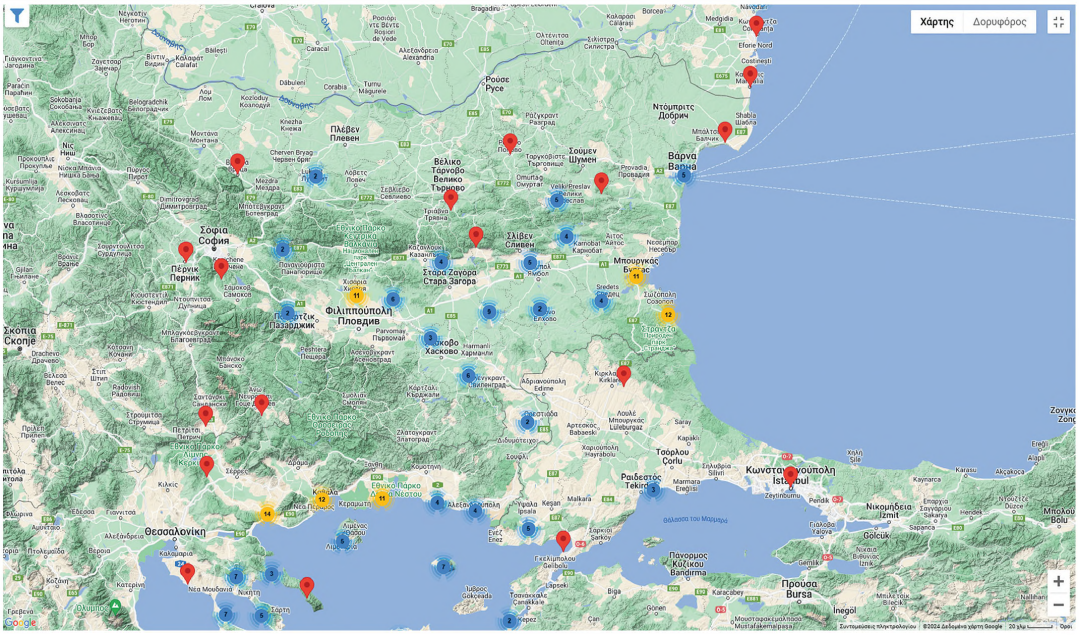

Figure 2. The AtticPOT interactive map.

availability of the material[4].

A third case is **Mythotopia: Mythological Routes in Eastern Macedonia and Thrace project**[5]. Mythotopia highlights the region's cultural and touristic richness through extensive recording, and mapping of ancient myths related to Thrace. It developed a specialized digital repository containing numerous Greek and Latin texts and ancient artworks depicting 36 region-specific myths, thus creating over 200 references, providing diverse ancient literary sources on Thracian mythology.

STUDYING ATTIC POTTERY IN THRACE

After setting up the base of the study, namely building the repository, the next step is to focus on a specific topic, such as for example the Attic pottery. Therefore, aligning with initiatives like BAPD, the AtticPOT employed the developed repository as a base to map and better understand the presence of the Attic vases in ancient Thrace[6]. It focused on various scientific and artistic aspects of Attic pottery, which dominated in the ancient Greek world from the 6th century BC onwards. After collecting the published painted pottery in the examined region, AtticPOT explored the distribution, uses, and preferences for Attic vases across ancient Thrace. Namely it covered sites located in a geographical area shared nowadays between Greece, Bulgaria, Turkey, and Romania. Combining in its methodology traditional with ICT tools, it proceeded to the examination of a large set of vases dated from the 6th to the 4th century BC. Furthermore, studying the presence of Attic pottery in various contexts, AtticPOT aimed to uncover exchange networks, usage patterns, and local preferences[7].

AtticPOT's repository hosts published data coming from a great range of sources (i.e. proceedings, reports, catalogues), covering simultaneously various contexts and collections. To manage the extensive material, researchers may navigate the vase records using browse, search, sort, and export functionalities. An interactive digital map (**Fig. 2**) provides a dynamic visualization of the vase distribution, filtered through comprehensive search criteria, including shapes, iconography, painters, potters, etc.

[4] *Avramidou and Tsiafaki* 2022; *Chioti, Avramidou and Tsiafaki* 2019; *Mourthos and Tsiafaki* 2022:217-218; *Michailidou et al.* forthcoming; *Tsiafaki, Michailidou and Chioti* 2020; *Tsiafaki et al.* forthcoming.
[5] https://mythotopia.eu/
[6] *Tsiafaki* 2022.
[7] *Michailidou* 2022.

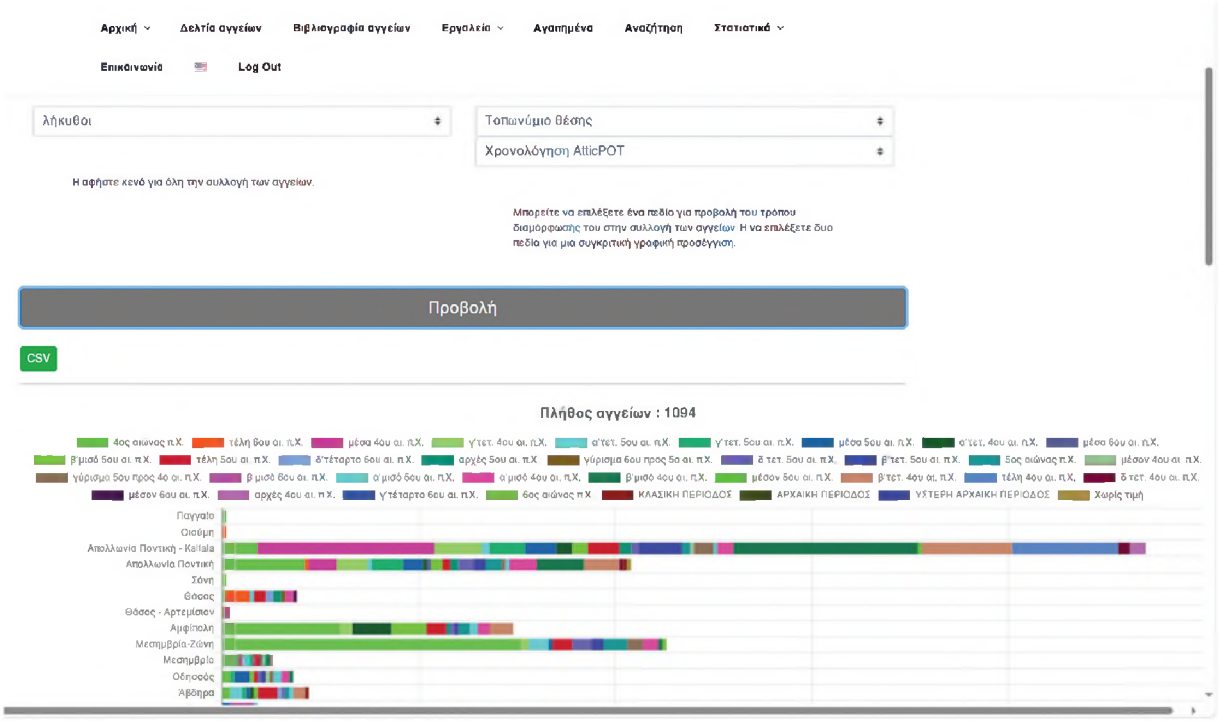

Figure 3. AtticPOT quantitative analysis tool.

Moreover, advanced research tools (**Fig. 3**) allow users to perform detailed analyses, saving favorites, and conducting quantitative analyses to uncover patterns and trends. Despite the project's official end, the ongoing process has amassed a robust collection of over 5,400 vases, approximately 8,700 bibliographical entries, and information from 215 sites across Greece, Turkey, Bulgaria, and Romania, thus enabling a more accessible and detailed study of Attic pottery across the region[8].

Using these tools for the research and study AtticPOT resulted in interesting observations and conclusions. For example, a focus and preference on a select range of vessel types (e.g., kraters, lekythoi) within the Attic pottery repertoire has been observed, which could be related to their function and context[9]. The study of a specific shape provided information on a deeper level. For instance, one of the most popular shapes, kraters, are found throughout the region, but their presence varies significantly in terms of quantity. Moreover, a great number of them have been unearthed in coastal sites. This could be due to the fact that coastal sites are likely more extensively excavated or might be related to historical factors associated, for example, with networks and routes of commerce. A great number of the kraters do not preserve clear finding contexts. Those, however, with known excavation sites mostly come from cemeteries and sanctuaries, predominantly from the 5th and 4th centuries BC. Unless future published data alter this observation, this pattern highlights the fact that they may played a clear role in funerary and religious traditions, at least in specific areas[10].

The other most popular shape of Attic painted pottery in ancient Thrace is lekythos. As regards the 4th century lekythoi, most of them are found in coastal regions, but it is worth mentioning that a significant number of them come from just five sites or has unknown provenance. To the latter may due, as it has been suggested in the case of the kraters, that these sites could be better excavated. Taking again into consideration the kraters, we may assume that coastal Greek colonies could have served as major hubs for Attic pottery trade. Worth of note is that nearly all lekythoi from known

[8] *Tsiafaki, Michailidou and Chioti* 2020; *Michailidou* 2022; *Tsiafaki et al.* forthcoming; *Michailidou* 2022.
[9] *Tsiafaki et al.* forthcoming.
[10] *Avramidou, Tsiafaki* 2022; *Tsiafaki et al.* forthcoming.

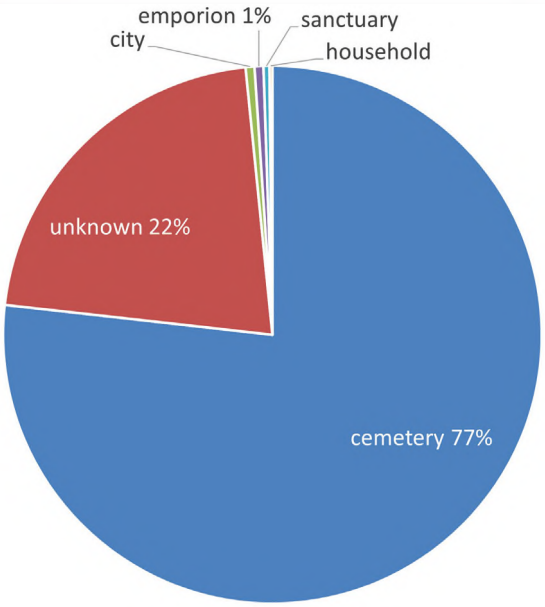

Figure 4. Context of the Attic 4th century lekythoi of Thrace.

contexts are discovered in cemeteries (**Fig. 4**), highlighting their role in funerary practices and rituals. Very few are found in sanctuaries, possibly as offerings, indicating a limited role in religious practices. The same limited presence applies so far to civic and domestic contexts[11].

Apart from shapes, the next important aspect of Attic painted pottery is iconography. The examination of the general distribution of popular iconographic themes (6th-4th century BC) in the AtticPOT repository resulted in several interesting trends. Floral and decorative motifs seem to prevail, while depictions of animal and Dionysiac scenes are also prominent, along with conversations, mythical creatures, domestic scenes, and warriors[12]. Dionysiac scenes stand out, spreading across both coastal and inland Thrace and appearing on various vessel types. Many Dionysiac scenes are found on sherds of unidentified vessels and often come from unknown or unpublished contexts. Those with known contexts are primarily discovered in cemeteries and sanctuaries. Chronologically, Dionysiac scenes are most prevalent in the 5th century BC, followed by the 4th century BC, with limited occurrences in the 6th century BC[13].

Technologies like those employed for the AtticPOT implementation facilitate detailed analysis of specific case studies, whether individually or comparatively. For instance, in exploring the contexts of 4th century lekythoi, distinct archaeological sites emerge as focal points for understanding the distribution and significance of these artifacts. One notable site is Mesembria-Zone, whose necropolis has yielded a substantial quantity of 4th century lekythoi[14]. Excavations in the necropolis of Ainos have also uncovered numerous 4th century lekythoi, highlighting the city's role as a market and distribution hub for Attic pottery during this period[15]. Moving to northern Thrace, near the ancient colony of Apollonia Pontica, Kalfata, cemetery, typical of Greek cities and colonies, has yielded numerous 4th century lekythoi[16].

In summary, the AtticPOT work exemplifies the transformative impact of ICT in classical archaeology, particularly regarding ancient Thrace. The developed digital tools provide the researchers the possibility to analyze extensive datasets, uncover intricate patterns, and gain nuanced insights into archaeological inquiries. ICT tools used in combination with traditional methods may facilitate systematic investigation into pottery typology, chronology, provenance, and cultural context, providing valuable resources. For sharing its research findings and engaging the scholarly community, AtticPOT adopted a hybrid approach of dissemination, both "traditional" and digital, organizing workshops that fostered collaboration among researchers from Greece, Turkey, and Bulgaria. This interstate effort culminated in a printed volume featuring contributions from esteemed scholars, showcasing diverse perspectives on the topic[17], as well as non-predicted in advance outcomes, such as a comprehensive presentation on the history of research into Attic deco-

[11] *Tsiafaki, Mourthos, Michailidou* forthcoming.
[12] *Tsiafaki et al.* forthcoming; *Michailidou* 2022: 48-51.
[13] *Tsiafaki et al.* forthcoming.
[14] E.g. Archaeological Museum of Komotini (МК/АГК 3557); *Iliopoulou* 2015: 61-71; *Iliopoulou and Pardalidou* 2022; *Tsiafaki, Mourthos, Michailidou* forthcoming.
[15] *Şahin* 2016; *Tsiafaki, Mourthos, Michailidou* forthcoming.
[16] *Damyanov* 2022; *Tsiafaki, Mourthos, Michailidou* forthcoming.
[17] *Tsiafaki et al.* 2022.

rated pottery in Bulgaria[18].

The issue of iconography, as a key aspect for extracting further knowledge on the region of ancient Thrace and its inhabitants, is also significant for the next thematic area examined here, that of the Thracian myths.

STUDYING THE ICONOGRAPHY OF THRACIAN MYTHS

Thrace boasts a rich mythological legacy, with numerous Greco-Roman artifacts coming from various eras to depict Thracian myths and to be housed in collections worldwide. Those myths are the topic of **Mythotopia** focused on exploring and promoting Thrace's mythological wealth along with its exploitation for tourism strengthening. In this case there is an integration of the traditional methods of classical studies (philology, archaeology) with ICT, leveraging tools like GIS, repositories, and interactive platforms. From the archaeological perspective -of interest here-, there is a significant number of ancient artifacts to meet contemporary tourism demands by creating immersive and educational experiences centered on Thracian myths. Moreover, by studying the iconography of these myths, researchers gain insights into artistic perceptions, cultural practices, religious beliefs, regional identity, and interactions with the Greco-Roman world.

At the heart of Mythotopia is a repository containing material related to the 36 selected myths related to Thrace. The repository includes over 300 ancient texts and references, along with more than 300 artifacts associated with these myths. Integration of multimedia and POIs enhances engagement, providing contextual information for more immersive experiences and understanding of Thracian myths. These sources encompass a wide array of philological, archaeological, and scientific materials. Central to the repository are Greek and Latin texts, which cover diverse genres such as epic poetry, historiography, tragedy, and other literary forms, from the works of approximately 95 ancient writers. All this information is available to the researchers as well as the visitors, tourists, and general audience.

Moreover, Mythotopia extensively utilizes archaeological artifacts of Greek and Roman origin. Decorated vessels, particularly Attic pottery adorned with mythological imagery, contribute to understanding the appeal Thracian myths had to Greek audiences[19] and the influence of Greek imports on Thracian taste. Sculptural artifacts (**Fig. 5a**) offer visual representa-

a b

Figure 5. a. Orpheus, Euridice and Hermes. Marble relief, 1st century BC-1st c. AD, Louvre museum (Paris) no Ma 854; **b.** Orpheus taming the animals. Mosaic floor from Miletus, 180-200 AD. Antikensammlung der Staatlichen Museen (Berlin), no. 72.

[18] *Banev* forthcoming.
[19] *Tsiafaki* 1998; *Tsiafaki* 2016.

Figure 5. c. Orpheus playing his lyre. Gold stater of Lampsakos, 387-334 BC. Münzkabinett der Staatlichen Museen (Berlin), no. 18215944; **d.** The murder of Orpheus on a gold-plated silver rhyton, 420-410 BC. Vassil Bojkov Collection, Sofia.

tions of mythological themes and characters, providing insights into artistic interpretations of Thracian myths and their significance in ancient iconography. Thracian myths are also depicted on mosaics (**Fig. 5b**) and coins (**Fig. 5c**), as well as on some elaborate and rare items, such as a gold-plated silver rhyton from Sofia (**Fig. 5d**). These artifacts serve as primary evidence as well as visual stimuli, offering material manifestations of mythological themes and characters. Selected photographs of these artifacts, used after permission, enrich the provided resources[20].

The rich material of Mythotopia draws exclusively from scientific publications, repositories, and official websites of institutions. This material fueled the development of a user-friendly platform and mobile application that integrates diverse information related to Thracian myths and cultural landscapes, offers touristic routes, and serves as an educational resource. Voiceover functionality to aid users with visual impairments ensures inclusivity and broadens access. Moreover, Mythotopia extends its impact beyond tourism by providing educational content aimed at secondary school pupils. Finally, Mythotopia also prioritizes "traditional" dissemination, through participation in conferences and the publication of a collective volume[21], pointing again to a combination of digital with analog.

GEOSPATIAL RESEARCH AND THE AEGIS LAB

Established in 2020, the **Archaeological GIS Laboratory (AeGIS Athena)**[22] marks a significant advancement in the study of cultural landscapes and human-environment interactions. Building on previous expertise of GIS technologies[23], AeGIS Athena serves as a hub for high-resolution documentation, mapping analysis, and 3D visualization. It supports diverse research inquiries with flexibility, utilizing both advanced and open-source GIS tools like QGIS to explore various perspectives and approaches in archaeological research. For instance, by integrating **symbology and quantitative analysis** techniques with the extensive dataset from AtticPOT, the distribution and characteristics of Attic pottery in ancient Thrace was further explored. In one case study, the utilization of custom-made symbols to visualize the occurrences of rare pottery shapes across various Thrace sites (**Fig. 6**) facilitated a comparative examination of spatial distribution patterns, providing nuanced insights into the

[20] *Vacalopoulou et al.* 2023.
[21] *Tsiafaki et al.* 2023.
[22] https://aegis.athenarc.gr/
[23] *Tsiafaki, Evangelidis* 2006.

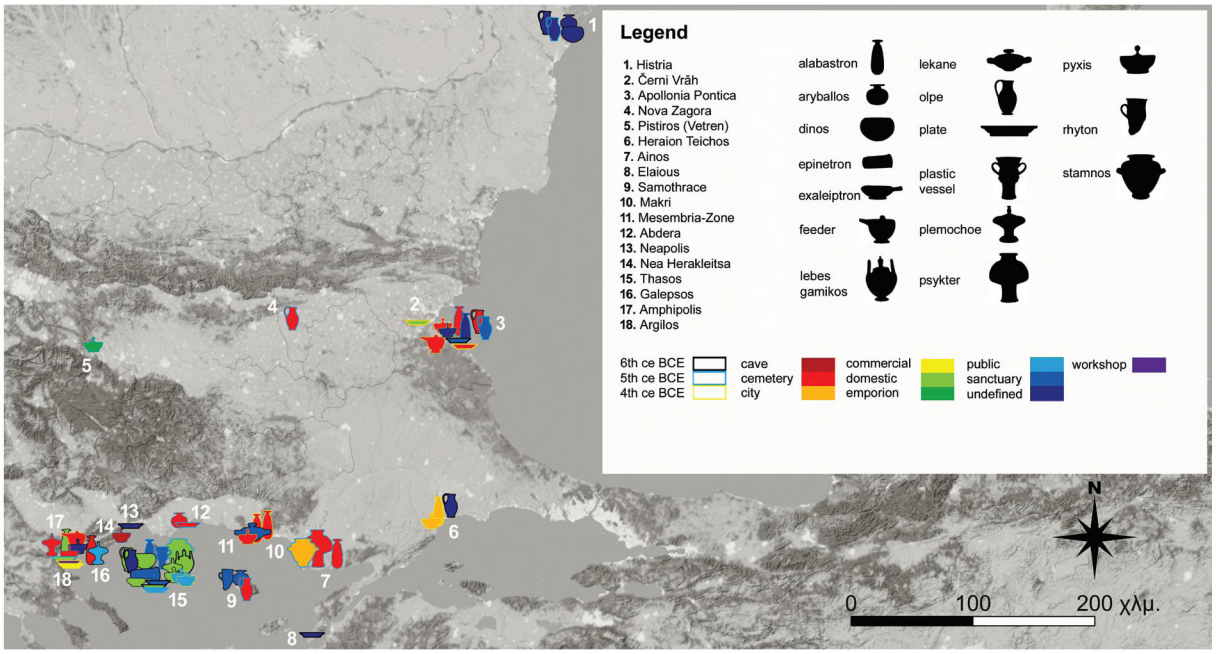

Figure 6. Map showing the distribution of rare shapes of Attic pottery, using custom made symbols showcasing the shape, the context and the date.

geographical and temporal trends of these rare shapes[24].

Moreover, the same integration yielded fruitful results in another case study. This time the focus was on Attic pottery found on sites located in Aegean Thrace, with emphasis on the area of Pistyros-Pontolivado[25]. By employing spatial analysis techniques and customized symbology, the distribution of Attic pottery was systematically mapped out, thus allowing the engagement in discussions regarding trade networks, cultural interactions, and stylistic preferences prevalent in the region during the 6th to 4th centuries BC. Through the visualization and analysis of Attic pottery distribution, valuable insights into the dynamics shaping the exchange and diffusion of material culture in this area were retrieved. To effectively communicate these complex archaeological patterns, the AtticPOT employed symbology techniques including heat maps, which use color

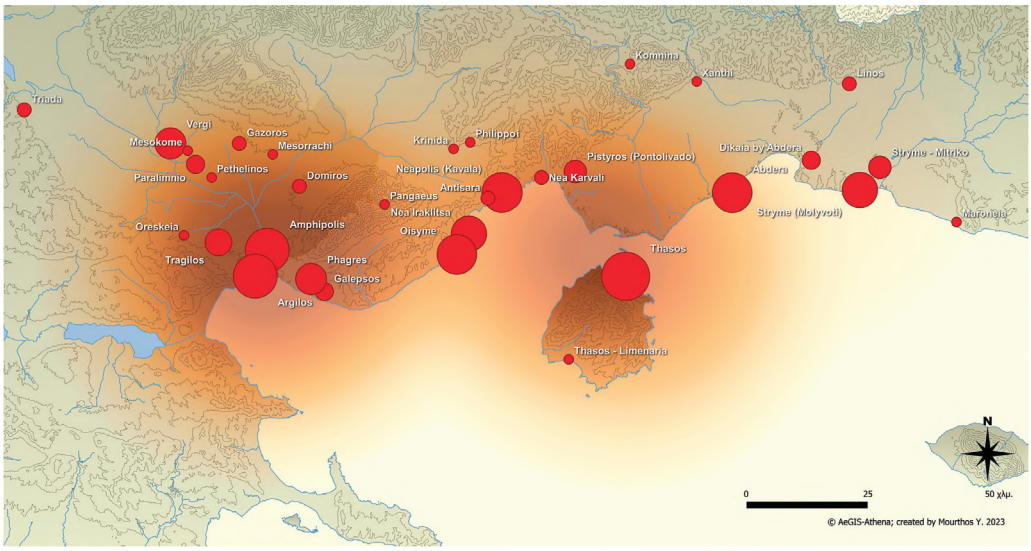

Figure 7. Heat map of the total distribution of Attic pottery (6th-4th century BC) in the area around Pontolivado.

[24] *Mourthos, Tsiafaki* 2022.
[25] For the site see *Papadopoulos* 2022.

Figure 8. Map combining a heat map, Nearest Neighbor Network analysis of AtticPOT data and the Roman road network in the area of ancient Thrace.

intensity to illustrate the density or frequency of phenomena. The analysis of AtticPOT data with GIS software generated **heat maps with quantitative symbology** examining the distribution and quantities of Attic pottery (**Fig. 7**)[26].

Combining the data from the AtticPOT repository and GIS software, trade routes and networks were explored by analyzing the distribution of rare shapes in ancient Thrace. However, our current focus includes a Five-node Nearest Neighbor Network analysis across the entire AtticPOT dataset to map connectivity between archaeological sites. Interestingly, our findings align significant portions of this network with the Roman road network from the Barrington Atlas in ArcGIS Hub (**Fig. 8**). This correspondence possibly suggests a continuity in trade routes from the Archaic and Classical periods to Roman times, highlighting enduring economic and cultural exchanges over centuries.

Finally comes **landscape archaeology** and the study of natural and anthropogenic landscapes in Aegean Thrace. Using data provided by the Lab of Applied Soil Science of the Aristotle University of Thessaloniki, AeGIS Lab created soil maps to investigate the influence of environmental and cultural factors on ancient economy and settlement patterns. The study focused on the area of Vafeika, Abdera, and Bergepolis (Koutso), early Thracian sites situated in areas affected by the river Kosynthos. By analyzing soil composition within buffer zones around these sites, the research explored how alluvial processes and extensive fluvial landscapes impacted ancient economy and settlement patterns. The findings underscored the pivotal role of fluvial landscapes in shaping the distinct economic activities of the region[27].

CONCLUSIONS

The utilization of digital tools in studying Ancient Thrace offers transformative insights, particularly in managing vast analog data sources. Establishing interconnected repositories and aggregators for archaeological finds, literary texts, inscriptions, and research bibliographies is crucial for preservation and collaboration among scholars. The rich history, mythology, and tourism potential of Thrace make it a compelling super-region. GIS tools enable quantitative analyses, facilitating studies on population movements, trade networks, and landscape dynamics. These technological advancements revolutionize archaeological research, enhancing our understanding of Thracian culture and history while potentially influ-

[26] A couple of them will be published in *Tsiafaki and Amoiridou* forthcoming.
[27] *Tsiafaki, Evangelidis* 2022.

encing economic growth and cultural policies.

To truly unlock the potential of digital tools in studying ancient Thrace, collaboration is necessary. It's crucial for institutions and researchers of the states that share the lands of ancient Thrace to join forces. The rich and complex heritage of Thrace can only be fully appreciated through a cooperative effort in collecting, analyzing, and sharing data, a teamwork that will not only deepen our understanding of the region's history and cultures but will also help preserve and interpret them in a more integrated way.

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Използване на дигитални инструменти в изследванията на Древна Тракия

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Отделът за култура и творчески индустрии на Изследователски център Athena в Ксанти (Гърция) се фокусира върху използването на различни дигитални инструменти за археологически изследвания. Чрез различни проекти се използва широк набор от дигитални инструменти за изучаване на историята и археологията на древна Тракия. Въз основа изследването на различни критерии са анализирани разпространението, употребата и културното значение на атическите вази в древна Тракия. Изследването на древните митове и връзката им с тракийския ландшафт показа културния и туристически потенциал на Източна Македония и Тракия. Освен това, използвайки ГИС софтуер, лабораторията AeGIS проучи различни археологически теми чрез използване на символи и инструменти за количествен анализ, както и топлинни карти и инструменти за реконструкция на мрежа.