

CONFERENCE

**Mapping the past plotting the future.
GIS in archaeology, maturity and implementation, Proceedings of the
workshop organised by the AeGIS Athena Lab, at the British School at
Athens, Thursday 30 March 2023**

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Introduction

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Conference proceedings comprise nine of the thirteen papers that were initially presented at the international workshop entitled ‘Mapping the Past, Plotting the Future. GIS in archaeology, maturity and implementation’ (https://aegis.athenarc.gr/?page_id=533), organized by the AeGIS Athena Lab along with one additional contribution from one of the moderators who actively participated in the concluding discussion. The workshop took place on March 30, 2023, at the British School at Athens.

Beginning with the recent establishment of the AeGIS Lab in Xanthi (<https://aegis.athenarc.gr/>), the workshop was organized with the purpose of addressing fundamental questions and cultivating a deeper understanding of the practical integration and broader implications of GIS technology in archaeological research and practice in Greece. Despite numerous articles, books, and lectures¹ delving into the symbiotic relationship between archaeology and GIS, key questions persist within the largely conservative community.² All this prompts broader inquiries,³ leading us to organize a one-day scientific meeting to discuss the relevant matters.

The volume, which is the outcome of this meeting, unfolds an interconnected series of papers, each contributing to the overarching theme of ‘Mapping the Past, Plotting the Future’. The title is born out of our aspiration to delve into the role and evolution of Geographic Information Systems (GIS) specifically in the context of Greek and Mediterranean archaeology. Since the early attempts to apply GIS⁴ in archaeological research in Greece, numerous developments have unfolded alongside the rapid evolution of technology, fundamentally altering the nature of GIS applications.

¹ The literature in the subject is vast and continuously increasing (see Sarris in this volume). There are numerous recent lectures, conferences, and publications exploring the relationship between archaeology and GIS. For general approaches to GIS, see Gillings *et al.* 2020, the classic manual by Wheatley and Gillings 2003 and the one by Conolly and Lake 2006 but also the overview by Verhagen 2018. For an overview of GIS in Greek archaeology see Sarris and Dederix 2014. In recent years, a growing number of ongoing lecture series, online GIS projects, and various large-scale initiatives like the ARETE project (http://www.aretecooperativa.com/index_en.html) have further enriched this field in Greek archaeology. Notable examples (to name some of many) include the ATLAS seminars (<https://www.ebsa.info/pages/page.php?page=14>), the recently initiated Mapping the Past online lectures (https://aegis.athenarc.gr/?page_id=760) by Athena RC, the Dipylon project (<https://dipylon.org/en/>), the Mycenaean Atlas Project (<https://helladic.info/Usage.php>) but also the Greek Ministry of Culture’s cadaster (<https://www.arxaiologikoktimatologio.gov.gr/en/content/about-archaeological-cadastre>) all of which provide valuable data and methodologies that enhance the integration of GIS in archaeological research and practice.

² Huvila *et al.* 2018.

³ Brouwer 2017.

⁴ Dann and Yerkes 1994; Kotsakis *et al.* 1995; Sarris *et al.* 1996; Romano 1998; Bevan 2002; Kotsakis and Ntafou 2002; Tsiafaki and Evangelidis 2006; Katsianis *et al.* 2008; Farinetti 2011.

Open-source free GIS, exemplified by QGIS,⁵ has expanded and facilitated archaeological research by making GIS technology accessible, cost-effective, collaborative, customizable, educational, adaptable to local contexts, and subject to continual improvement. Especially for archaeological survey work in Greece, advances in GIS have fundamentally transformed the field, likely even more so than for excavations.⁶ Recent work discusses⁷ the paradigm-shifting importance of GIS and spatial analysis in archaeological survey practice, highlighting how GIS has revolutionized the collection, interpretation, and dissemination of spatial data in archaeological surveys. This evolution has facilitated more comprehensive and nuanced understandings of ancient landscapes and human activities, a transformative impact also evident in recent reviews of Mediterranean survey methodologies. A significant role in this advancement has been played by the integration of remote sensing with GIS and spatial analysis. Remote sensing technologies, including aerial photography, satellite imagery, and LiDAR, provide high-resolution data that allow for the identification and analysis of archaeological features that might be invisible or inaccessible through traditional survey methods.⁸ This integration has empowered a broader range of individuals and institutions to engage meaningfully in archaeological investigations, making this synergy a cornerstone of modern archaeological practice that significantly enhances our ability to investigate and understand ancient environments and human activities.

Within this context, the first part of the workshop title, ‘Mapping the Past,’ signifies an investigation into the current application of GIS technology, emphasizing its role in creating spatial representations and maps of archaeological sites, landscapes, and historical data. On the other hand, ‘Plotting the Future’ introduces a forward-looking perspective, suggesting an examination not only of the historical applications but also of the potential future uses of GIS in archaeology. These two fundamental temporal axes served as the guiding principles in curating a collection of papers contributed by specialists and scholars who are engaged in active excavations and research in the archaeology of Greece. The papers probe the extent of development, refinement, and sophistication that Geographic Information Systems (GIS) applications have attained in the field of archaeology, addressing questions about the maturity and establishment of GIS as a tool within archaeological research and practice. Moreover, they also explore the ‘Implementation’ aspect, namely the practical application and integration of GIS in archaeological projects. This entails exploring its effectiveness in real-world scenarios and examining the challenges and successes associated with implementing GIS methodologies in archaeological research. The papers are organized into three thematic sections. They progress from a theoretical overview to the application of GIS in excavations and the management of archaeological sites, the use of new technological tools in field surveys, and finally, GIS analysis as an archaeological tool.

The volume opens with **Apostolos Sarris’** contribution, ‘The polymorphism of archaeological GIS: unfolding the archaeological dimensions of GIS’. Sarris highlights the transformative impact of GIS on archaeology, illustrating its evolution from basic mapping to complex analyses that integrate diverse datasets. He explores how innovations in sensors, Big Data, machine learning, and artificial intelligence have opened new research avenues while also presenting challenges, such as the need for standardized methodologies, the integration of sophisticated tools, and transparency in spatial analyses. Sarris emphasizes the importance of combining GIS with other analytical methods to gain enriched insights. He underscores the need for improved education and training in archaeological GIS (a point raised also by other papers in this volume), advocating for a shift from teaching basic skills to fostering creators and innovators in the field. As the archaeological community grapples

⁵ Orengo 2015.

⁶ Bintliff 2012.

⁷ Knodell *et al.* 2018. Attema *et al.* 2020; Knodell *et al.* 2022.

⁸ See a general introduction Comer 2014 but also the recently published Verhoeven *et al.* 2021. A recent conference *Lidar and Landscapes in the Archaeology of Greece: An International Workshop 15 March 2024* organized by the American School and A. Knodell encapsulates well the growing interest in Greek Archaeology.

with readiness for the next phase of GIS impact, Sarris calls for a more integrated approach to address complex archaeological questions, ensuring that the field can fully exploit the capabilities of next-generation GIS technologies.

Within this theoretical framework described by A. Sarris, the collaborative article ‘From intra site to macro scale GIS analysis’ by **Vassilis Evangelidis, Yiannis Mourthos, and Melpomeni Karta** offers an overview of the AeGIS Lab’s GIS work and approach. Their article elucidates the practical applications and methodologies employed by the AeGIS Lab while highlighting the actual difficulties practitioners face when applying GIS in different contexts. Presenting four different cases spanning from intra-site to macro scales—the GIS platform of the Karabournaki excavation in Thessaloniki, the study of fluvial landscapes in Aegean Thrace, the network analysis of the flow of Roman pottery to the sanctuary at Kalapodi, and the merging of GIS data with game engines—the article highlights the role that the AeGIS Lab aims to play in research and GIS education in Greece.

Addressing a significant practical challenge, **Spiridon Mousouris, Yannis Lolos, and Christina Giannakoula’s** article, ‘Methodology and guidelines for geovisualizing archaeological excavation data: the case of Sikyon, Greece,’ focuses on the application of GIS in handling large archaeological sites. Using the ancient city of Sikyon as a case study, they discuss the methodology and challenges encountered in visually representing excavation data within a GIS framework. The article outlines guidelines for geovisualizing archaeological data, emphasizing the use of common visualization characteristics, adapting User Interface (UI) organization rules, and addressing stratigraphic complexity with extrusion schemes to support scalable, intuitive, map-centered interfaces that reveal hierarchies and geospatial relations while maintaining a decluttered UI for effective data dissemination.

The paper ‘Integrating field and specialist data in a 3D GIS framework: a holistic solution’ by **Rosie Campbell, Michael J. Boyd, James Herbst, Hallvard Indgjerd, Nathan Meyer, and Colin Renfrew** explores the application of a 3D GIS system to manage the complexities of archaeological excavation at Dhaskalio on the central Aegean island of Keros. The team utilized digital tools, including iPad-based geo-located data and photogrammetry, to replace traditional paper methods, creating a comprehensive 3D GIS platform. This platform integrates traditional GIS functionalities, enhancing the system’s analytical capabilities by combining 3D models with tabular data, specialist analyses, and photographs. It acts as a ‘one-stop shop’ for interpreting the excavation, offering multi-layered 3D views and integrating geo-located data from both the field and subsequent specialist studies. While acknowledging the system’s demands in terms of time, financial resources, and patience, the authors emphasize the potential of this ‘living’ 3D GIS for broader accessibility and long-term use, which can significantly enhance future excavation practices, offering a dynamic approach to archaeological research and data management.

The promise of a dynamic and immersive spatial analysis platform which enhances the depth and precision of spatial understanding appears in the paper by **Markos Katsianis** ‘3D GIS in archaeological excavations: linking documentation with analytic and synthetic workflows’, which explores the evolving role of 3D GIS in the documentation of archaeological excavations (Paliambela Kolindros, Agia Triada in Karystos, Toumba Thessaloniki and more recently Amphipolis) over the past two decades. While there has been progress in integrating 3D workflows and enhancing data capture capabilities, the full analytic and synthetic potential of 3D GIS in archaeological excavations remains largely untapped. Katsianis highlights persisting challenges related to existing documentation workflows, technological changes, data bottlenecks, and organizational capacities, particularly in the diverse adoption of digital methods within Greek archaeology. Similarly to Sarris and Evangelidis *et al.* he raises fundamental questions about the readiness of the archaeological community to embrace digital tools, suggesting that leveraging the full potential of 3D GIS may require significant shifts in perceived roles and research activities to achieve a holistic solution.

On a more practical, yet crucial level, the paper ‘Born-digital field survey data: using a KoBoToolbox workflow in the west area of Samos Archaeological Project’ by **Michael Loy, Alexandra Katevaini, and Anastasia Vasileiou** demonstrates how we can overcome the difficulties of mapping by utilizing cost-effective and easy-to-handle technologies like KoBoToolbox. This platform, originally designed for field data collection in humanitarian aid zones, works both online and offline, allowing the creation and deployment of custom-built forms for data acquisition in various contexts, including environments with poor or no cellular internet access. Users can design forms using KoBo’s online form builder or by uploading an XLSForm specification, which can include dropdowns, multiple-choice options, free-text fields, and image media captured through a device’s (tablet or smartphone) camera. The authors explore the practical application of KoBoToolbox for on-the-fly recording in archaeological GIS and database workflows during a field survey in western Samos (WASAP), presenting the advantages (efficiency, flexibility, immediate transitions from data collection to visualization, and speeding up data entries) as well as the significant challenges and complexities (hardware costs, maintenance, connectivity issues, and potential suitability issues) of using this tool in the field.

In the ever-evolving landscape of mobile technologies, the integration of cost effective cutting-edge applications and operation systems with credible broadband connectivity has become indispensable to propel the field into a new era. In his paper ‘ARCH_DATA APK: Mobile computing in the service of archaeological research’, **George Malaperdas** introduces ARCH_DATA, a mobile application designed to redefine archaeological field surveys through the familiar use of Android smartphones. Short for Archaeological Data, ARCH_DATA simplifies and accelerates data collection, analysis, and maintenance during fieldwork, offering adaptability to diverse survey requirements and creating a geospatial archaeological database integrated into GIS environments. By integrating descriptive and photographic data, ARCH_DATA functions on standard smartphones and is easily customizable to suit different survey needs. Data can be exported and shared offline or online, generating a dynamic geospatial database for GIS integration. According to the author, its simplicity and mobile convenience ensures widespread applicability, simplifying and enhancing archaeological fieldwork and reflecting the future trend of mobile app utilization in scientific research.

Often intimidating for novices, yet crucial in GIS, are analytical tools like Least Cost Path (LCP) analysis, which are pivotal for determining optimal routes based on friction costs. In this context, Vyron Antoniadis, in his contribution ‘Exploring optimal paths, slope-dependent functions, and digital elevation models in the Greater Knossos area,’ delves into a thorough examination of various functions, LCP approaches, and Digital Elevation Models (DEMs) with different resolutions in the Greater Knossos area. This region, abundant in archaeological monuments from the Minoan and Early Iron Age, serves as a significant testing ground for exploring the relationship between tomb placement and road paths. Linking theoretical models with empirical observations, Antoniadis experiments with the most effective slope-dependent functions, DEMs, and LCP outputs to illustrate the spatial distribution of tombs and the optimal paths leading to and from harbors. By doing so, he highlights the need for data transparency and methodology as essential means for conducting nuanced and historically contextualized spatial analyses.

Will Kennedy’s paper, ‘Bridging the gap: Embedding spatial analyses in culture-historical discourse. Experiences from Jordan and Cyprus,’ explores the dual nature of spatial analysis through two projects: one in Petra, Jordan, and the other in Idalion, Cyprus. While spatial analyses, such as visibility analysis, site catchment analysis, and fuzzy resource maps (used by Kennedy in Idalion), are essential for achieving specific research goals, they can sometimes appear overly reliant on GIS methodologies. Kennedy highlights the benefits of spatial analysis’s independence from traditional archaeological approaches and its applicability to diverse research questions. However, he also acknowledges potential pitfalls, such as the risk of accepting problematic

premises without scrutiny and falling into a ‘methodological trap’ that neglects deeper culture-historical discussions. The paper advocates bridging the gap between quantitative spatial analyses and qualitative culture-historical discourse, a core issue that is also evident in the use of GIS in paleoenvironmental studies like **Anton Bonnier’s** paper ‘Methods of integration: combining archaeological and paleoenvironmental datasets within a GIS Framework’. Bonnier addresses the growing significance of human-environment interactions in archaeological research, especially amid global concerns for climate and environmental change. He emphasizes the necessity of utilizing both human and paleoenvironmental archives, along with proxy data, to study these dynamics. The paper focuses on the role of GIS as a versatile toolbox for integrative research, showcasing its capabilities in spatial mapping and quantifying land use patterns and diachronic developments over time. Drawing on examples from Attica and the Peloponnese, Bonnier discusses the challenges and possibilities of GIS-based research in landscape archaeology, focusing on socio-environmental dynamics. The paper emphasizes the integration of paleoenvironmental records with GIS land use modeling, highlighting the need for adapting chronologies and extracting spatial values from archaeological data for meaningful comparisons.

The papers in this volume collectively illuminate the dynamic interplay between GIS technology and archaeological methodology, underscoring the transformative impact that GIS aspires to have on Greek archaeology and tracing its evolution from conventional mapping to multifaceted dimensions. While all the papers highlight the immense potential of GIS, they also expose inherent challenges, such as the parallel development of similar methods and approaches that often lack methodological consistency. Handling large archaeological sites in a viable manner, both logistically and technologically, is one of these challenges, especially in Greece. S. Mousouris *et al.* illustrate that successful data management and visualization are critical for sites like Sikyon but are also plagued by limitations like data overload, integration difficulties, and visualization challenges. An ideal solution might be the ‘holistic’ approach presented by R. Campbell, M. Boyd *et al.*, who implemented a comprehensive 3D GIS system in the Keros excavation. This system demonstrates significant potential, but the authors recognize that this approach requires a time-consuming setup process, specialist skills, and expensive equipment, which can be a barrier for archaeological projects lacking access to such expertise and funding. M. Katsianis also highlights the potential of 3D GIS in excavation documentation, emphasizing its robustness for handling large datasets. He notes, though, that deploying such tools requires significant ‘socio-technical’ arrangements, including considerations related to established documentation and analytic practices, logistics, and user training requirements. These demands are a harsh reality for many archaeological projects in Greece and cannot be easily ignored or overcome. Developments in affordable hardware and software may open a window of hope for cost-efficient mapping projects, especially in archaeological surveys. The papers on KoBo Toolbox (by M. Loy *et al.*) and ARCH_DATA (by G. Malaperdas) offer practical solutions for data recording, each with its own advantages and shortcomings. Smartphones, with their lower cost and widespread availability, are ideal for quick and efficient data recording, but they may face limitations in handling complex tasks due to smaller screens and lower processing power. Tablets, on the other hand, provide a more comprehensive toolset with better visibility and processing power, making them suitable for detailed data collection and complex analyses, though they come at a higher cost and reduced portability. Both papers present viable solutions for field data recording but highlight the ongoing challenge of balancing cost, portability, and functionality in mobile GIS applications. In the context of tight budgets in archaeological fieldwork, the choice between using smartphones or tablets depends on the specific needs and resources of the archaeological project. Ultimately practicalities and resource constraints must be carefully considered to maximize the new potentials in excavation and field survey.

Another challenge involves integrating GIS and spatial analysis with traditional archaeological and historical methods to gain deeper insights into human-environment interactions. V. Antoniadis, in his paper on experimenting with additional slope-dependent functions and reassessing topographic evidence in Crete, argues that the primary objective of GIS research in archaeology is to disseminate comprehensive information to a broader audience. This enables researchers to leverage and compare findings for a deeper understanding of GIS-related analyses. He underscores the potential of GIS as a framework for understanding ancient land use and socio-environmental dynamics. W. Kennedy also underscores this potential, arguing that landscape archaeology, by integrating quantitative spatial analyses with traditional qualitative approaches, offers deeper insights into human-nature relationships without overshadowing culture-historical discussions. Both papers reveal the complexities and technical challenges involved in selecting appropriate models and functions for accurate analysis. They address the potential pitfalls of over-reliance on spatial analysis and advocate for a balanced approach that bridges quantitative methods with qualitative cultural-historical discourse. This highlights a critical tension in the field: while spatial analyses can offer valuable insights, they must be contextualized within broader archaeological narratives to avoid methodological traps. The need for meaningful analysis is further evident in the paper by A. Bonnier, who explores how paleoenvironmental records can be integrated with GIS-based land use modeling. Bonnier highlights the challenges of aligning time-series data with spatial contexts, emphasizing the necessity to enhance the resolution and volume of both human and environmental records, as well as to improve the quality of topographic data. Within this context improved data resolution, quality, and coverage of human and environmental records are crucial.

Of course, the papers in this volume can only touch upon some of the broader topics related to GIS in archaeology. What needs to be further explored are the issues that arose from the vibrant discussion following the oral presentations in the workshop: the pivotal role played by open and ‘clean’ data⁹ and their importance in fostering collaboration and advancing archaeological knowledge; the use of commonplace devices such as smartphones and tablets,¹⁰ which underscores the availability of GIS tools in the field; the need for standardization (as analyzed by Sarris in this volume) which will enable interoperability, comparability, and collaboration in handling archaeological data; the need for data curation, archiving, and digital repositories essential for preserving the integrity and usability of these datasets over time,¹¹ preventing data loss, and supporting long-term research initiatives; and, of course, the emergence of digital publication, which offers dynamic and interactive ways to present research findings. Last but not least, the urgent need for the introduction of GIS in standard academic training (as mentioned by Evangelidis *et al.* and Katsianis in this volume)¹² as a formal integration into archaeological curricula (at the moment only selectively applied) that will equip students in Greek universities with a basic set of skills from which they can later develop their own research initiatives and analyses.

As technology advances exponentially, additional issues beyond those already highlighted will inevitably arise, including ethical considerations¹³ such as data privacy and the representation of cultural heritage, the need for stronger and more nuanced interdisciplinary collaboration between archaeologists, geographers, and computer scientists,¹⁴ staying current with technological advancements such as artificial intelligence and machine learning, securing funding and resources, providing ongoing training and capacity building, enhancing public engagement, addressing data

⁹ Costa *et al.* 2014; Boyd *et al.* 2021; Heilen and Manney 2023.

¹⁰ Paukkonen 2023.

¹¹ Howland *et al.* 2020; Klehm 2023.

¹² Badey and Moreau 2018; Sonnermann 2019.

¹³ Dennis 2020.

¹⁴ Maggio 2018.

integration challenges, ensuring long-term sustainability, and situating Greek GIS projects within a global context.

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