Understanding Place

GIS and Mapping across the Curriculum

Diana Stuart Sinton and Jennifer J. Lund

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Contents

The Collaboratory for GIS and Mediterranean Archaeology (CGMA) is an interdisciplinary, inter-institutional endeavor that involves faculty at four undergraduate institutions: DePauw University in Greencastle, Indiana; The College of Wooster in Wooster, Ohio; Rhodes College in Memphis, Tennessee; and Millsaps College in Jackson, Mississippi. As one part of CGMA, DePauw has offered a seminar on Archaeology and GIS since 2003 as a collaborative effort across the four institutions. This seminar covers the methods, theories, and practice of field or lab research with library research in archaeological survey. Students are deeply immersed in the application of GIS to archaeology and apply that learning through a multistage practicum involving GIS-based survey work. CGMA students are also integrally involved in creating MAGIS (Mediterranean Archaeology GIS), our Internet-based GIS of metadata—data about data—from archaeological survey projects in the Mediterranean basin. For scholars and students worldwide, MAGIS provides an inventory of exactly what work has been done where, when, and how, allowing scholars worldwide to combine, and perhaps compare, survey data across the Mediterranean.

Chapter 11

Classical archaeology: Building a GIS of the ancient Mediterranean

Pedar W. Foss and Rebecca K. Schindler

Many archaeologists use GIS as a critical research tool, but it is seldom a focus of comprehensive instruction for undergraduate classical archaeology students.[1] In 2000 when we originally conceived of Collaboratory for GIS and Mediterranean Archaeology (CGMA), we did not envision an instructional component, but over the years the concept evolved so that teaching the theory and practice of GIS became a defining characteristic of the project. As archaeologists, we had previously learned GIS concepts and acquired relevant software skills as needed to apply the software mapping tool effectively to our specific research projects. We now recognize additional benefits of collaborative, inter-institutional teaching: our individual areas of expertise with GIS can be combined to generate the substantial, collective knowledge that fuels our instruction.

Intercampus collaborative (ICC) teaching can be an effective approach for certain academic subjects at small colleges and universities. Individually, our small departments do not have the luxury of maintaining enough faculty to offer either the breadth or depth that larger universities can. The Sunoikisis Project, a series of ICC courses in Classics, developed and successfully operated for several years by the Associated Colleges of the South (ACS), responded to these challenges by working collaboratively across multiple small college campuses.[2] We modeled CGMA after that program. The design of the Collaboratory pivoted around a multivalent intersection between peer institutions, teaching, and research, and the kindred disciplines of classical archaeology and anthropology. This ideally suited our roles at colleges where teaching is privileged, research is increasingly valued, and opportunities for students to apply their learning to real-world problems are prized.

As it now stands, CGMA has two parallel and equally important objectives—creating wider opportunities for undergraduate students to engage in the full process of archaeological research and creating a spatially searchable database of archaeological survey projects in the Mediterranean (MAGIS, or Mediterranean Archaeology GIS). Students from various disciplines (e.g., classical studies, anthropology, computer science, and geology) are engaged in different aspects of the project, and this diversity of backgrounds enables the students to participate in all stages of forming, constructing, testing, and using MAGIS.

Students have the opportunity to work on the CGMA project in three ways: the ICC seminar in the fall semester, spring-term work-study grants, and summer research internships. Through CGMA, we also complement the ACS Archaeology program, which offers an online archaeology course in the spring term and takes students to Turkey and Mexico for fieldwork in the summer.[3] Because MAGIS is such an integral component of the CGMA project, we will first describe the research problem that MAGIS addresses, and then how we involve students with all aspects of MAGIS and CGMA.

CGMA's approach to archaeological research in the Mediterranean

Over the past forty years, archaeology has shifted its emphasis from single-site investigations to regional studies, allowing archaeologists and historians to ask not just synchronic (single-period) questions, but broadly based diachronic (multiperiod) questions as well. Technological advances in data collection, storage, and analysis supported this change. One of the most important advances has been archaeologists' use of GIS, which permits us to present our analyses of spatial data through maps. (All properly collected archaeological objects have a spatial context that is crucial to their interpretation.)

Unfortunately, most of these datasets remain isolated from each other, trapped in localized and often proprietary databases. Individual scholars have pursued pan-Mediterranean studies of archaeological data, but their compilations are in analog form (often a catalog), making it difficult for other researchers to experiment directly with the same data. Alcock and Cherry (2004) recently examined the comparability of survey data collected in regional studies, and their important contribution includes a long list of Internet resources for survey projects. However, their work and other similar projects fall short of what is needed: a dynamic resource that is constantly updated with data from new studies. A comprehensive resource could assist archaeologists, anthropologists, and historians to investigate questions of social and political development, cultural interaction and diffusion, and economic exchange. Through a spatial interface, users could query the data and generate geographic visualizations from vast stores of site-specific data.

The technology exists to make such a large-scale project feasible and productive: secure, long-term, and high-capacity storage; powerful relational databases; GIS; and the Internet. Yet the conceptual and categorical conflicts inherent in the data are formidable. Practically every team of researchers has constructed different definitions for their data and different procedures for collecting and studying that data. Accordingly, the primary rubric offered by the Alcock and Cherry volume is side-by-side rather than head-to-head comparison. In other words, the data itself cannot be compared—only the general patterns indicated by the data. This diversity of data and process poses a major hurdle for doing unified searching and making integrated comparisons.

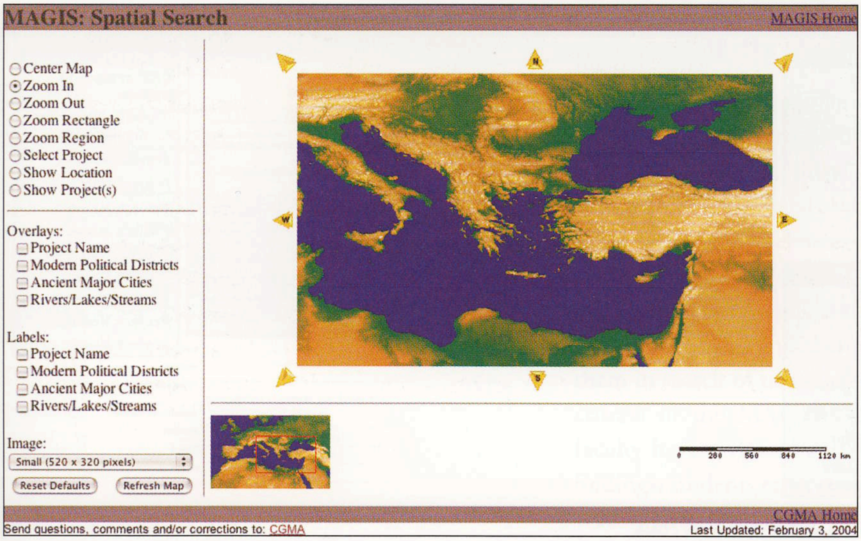

Figure 1. The area of interest for MAGIS, as seen through its Spatial Search page, beta version. The full extent is a rectangle extending from 20° N latitude, 15° W longitude in the southwest to 60° N latitude, 50° E longitude in the northeast. This area includes fifty-three countries, and covers the "extended Mediterranean" region (those regions connected to or significantly influenced by ancient Mediterranean cultures up to about AD 700).

Of course, before we can conceive of comparing survey data from the rich and diverse collection of Mediterranean area research, the data must first be collected and categorized. As a stepping stone, CGMA has been constructing MAGIS, a basic Internet GIS that serves as a geodatabase of metadata for Mediterranean survey projects.[4] The objective of MAGIS is to define and monitor the scope and scale of the worldwide body of research, as it grows. To build MAGIS, CGMA scholars and students first select archaeological survey projects and extract information from these surveys about what data was collected and how the data was stored. This information is then organized, stored, and linked to a detailed topographic map of the greater Mediterranean region (figure 1).[5] Scholars worldwide will be able to query survey data either spatially, by choosing a location, or through specific fields, by searching the data (figure 2). Our user interface, therefore, communicates both with the database and with the GIS software, and returns search results represented either in a list or a map, as the user prefers.[6] MAGIS will contain comprehensive and current bibliographies for each survey project, and therefore should become a first stop for anyone who wants to research archaeological surveys in the greater Mediterranean within the project limits.

The CGMA fall seminar and practicum

MAGIS and CGMA are profoundly intertwined, and students are integrally involved in the ongoing development of MAGIS, particularly during the ICC fall-semester seminar course on survey archaeology and GIS, which involves all four college campuses. This seminar also incorporates a practicum for survey research that is conducted by the individual instructors on the four respective campuses.

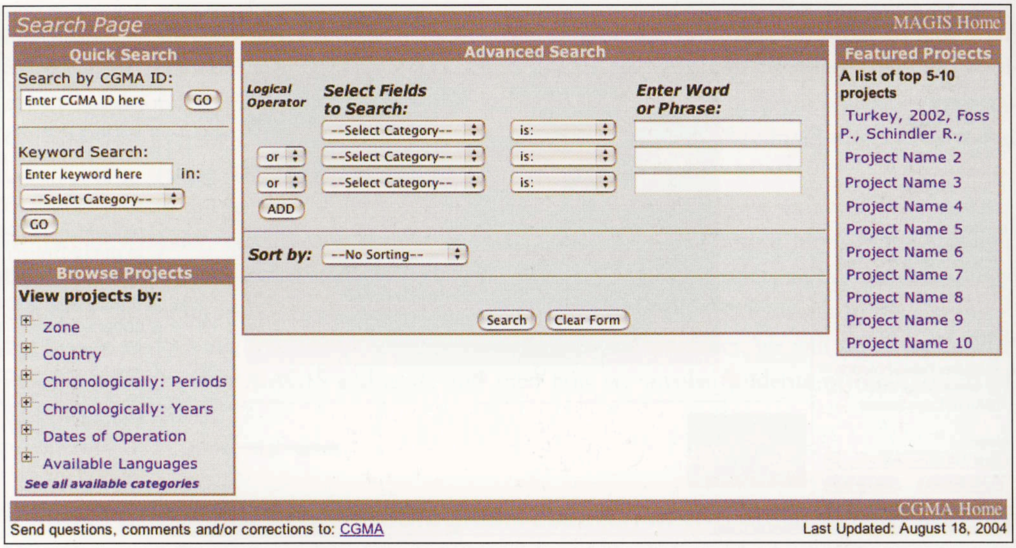

Figure 2. The database search page for MAGIS, beta version. Users have several search options: a simple keyword search, an ID number search (if the user has a favorite project, for which one knows the ID number, and wants to access it quickly), and an advanced Boolean search through multiple fields. Users may also browse through projects (lower left) by clicking through nested lists of geographic zones, modern countries, chronologies, and languages in which reports have been published. A list of most-requested projects is available on the right-hand side.

The seminar

We designed our semester-long ICC Seminar in Archaeology and GIS to introduce advanced undergraduates to methods, theories, and practice in primary (field or lab) and secondary (library) research in archaeological survey. Even though we have four institutions spread across several states participating in this ICC, the group size remains small (three to four students per school per year) and we create ample time to get to know one another through online chatting and at least one face-to-face meeting. The seminar meets synchronously online twice a week using the ACS Course Delivery System (CDS),[7] and the role of the lead instructor for the semester alternates among the four participating colleges. The lead instructor has primary responsibility for coordinating the syllabus and consults with other faculty members to develop lectures, exercises, and discussion on the history, methods, and theories of archaeological survey research. Moreover, each faculty member individually leads the students from their particular campus through a multistage practicum involving GIS-based survey work.

Throughout, students conduct individual projects that contribute to the construction of MAGIS. These projects are designed so that computer science students can work on databases, GIS, or Internet delivery programming under the supervision of the project programmer, and students in classical studies, anthropology, or geography can work on the collection, organization, and assessment of metadata from published survey projects in specific regions of the greater Mediterranean. For example, in 2003–2004, students tracked down surveys conducted in Cyprus, Greece, FYROM (Former Yugoslav Republic of Macedonia), Albania, Serbia-Montenegro, Austria, Germany, Italy, Tunisia, Jordan, and Israel.

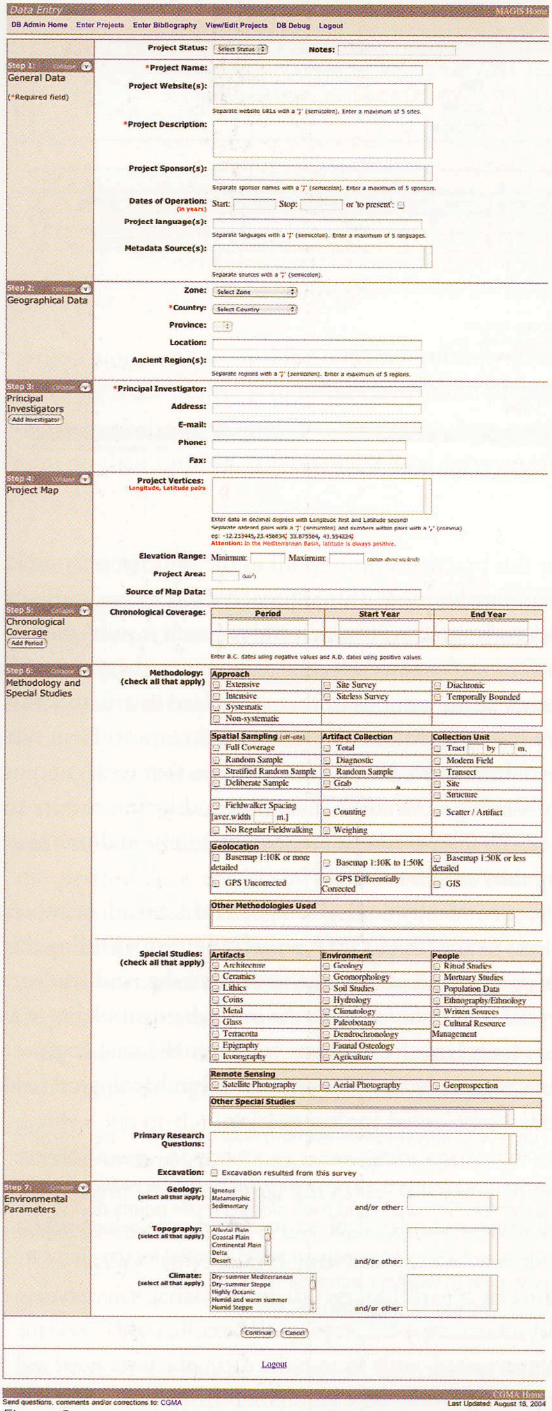

Figure 3a

A searchable database is only as good as the data within it. As part of their involvement with CGMA, students spend several hours each week outside of class time systematically wading through archaeological bibliographic databases, indices, and the Internet for references to field survey projects. They investigate the references, order necessary publications through interlibrary loan, and then comb through them in search of metadata that meets the criteria of the MAGIS categories. Once faculty have reviewed and approved these findings, students enter the data through a Web interface (figure 3). Researchers can enter data about their own sites through a data entry form on the Web. We recognize, however, that researchers and faculty from every discipline are notoriously bad at submitting and updating metadata. Thus the thorough, conscientious, and hard work of our undergraduate students will probably continue to be the primary method of data collection.

In the seminar we balance lectures and discussions, library-based research, GIS skills acquisition, and field work (the practicum). Participation in the development of MAGIS teaches students fundamental bibliographic research skills applied to archaeology, skills that are essential for graduate school but rarely taught at the undergraduate level. Library research is

Figure 3. The data entry and bibliography pages for MAGIS, beta version. Each step listed on the left-hand side of figure 3a is collapsible, making it easy to view and enter only the data one wishes to enter. Students are asked to first enter the data on a paper version of this page, so that there is a backup in case the Internet connection is lost during the entry process. Bibliographical references are entered in a separate, related database such that records can be associated with more than one project (figure 3b).

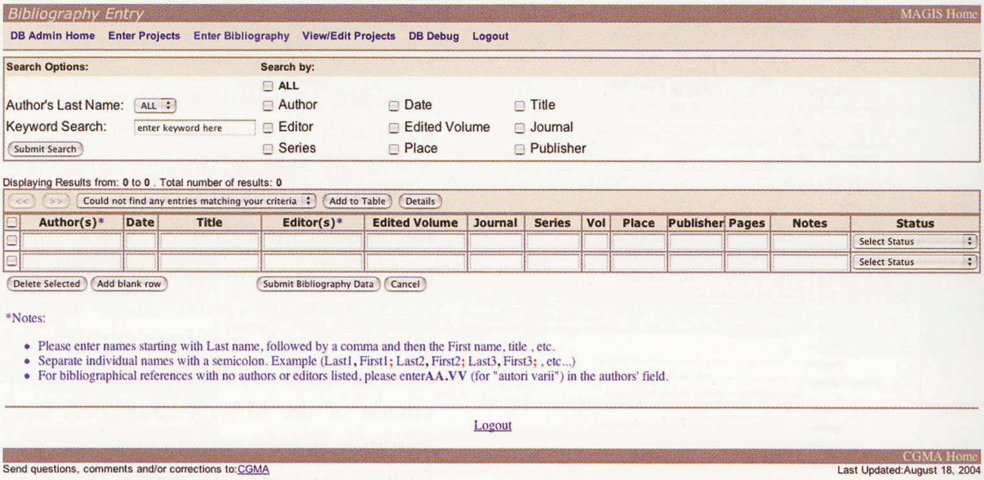

Figure 3b

more laborious than glorious, but we consider this practice as important as the more popular field experience gained on digs in the Mediterranean. Furthermore, this approach also exposes students to the importance of learning the various modern languages in which the research is published.

One of our most important sessions is the face-to-face meeting that happens midway through the semester, when all students and faculty gather at the campus of that year's lead instructor. This meeting is an integral part of the collaborative instructional mission for several reasons. First, during that time we provide students with an introduction to ArcGIS software, so that each campus team can use the software to carry out their distinct practicum.[8] There is also the opportunity to train students in data collection with handheld GPS (global positioning system) units and/or a laser transit (figure 4) that they can then use during the ArcGIS training.

Second, we have an open session, with students, faculty, and visiting CGMA board members, reporting on the current progress of, and problems facing, the CGMA project (figure 5). During this session the scholars model discussion and debate as they hash out the issues at stake, and students are encouraged to participate actively. The purpose is not only to solve the immediate problems or at least come up with promising approaches, but also to involve students in the intellectual engineering process of making a large collaborative project work. No scholar operates an archaeological field

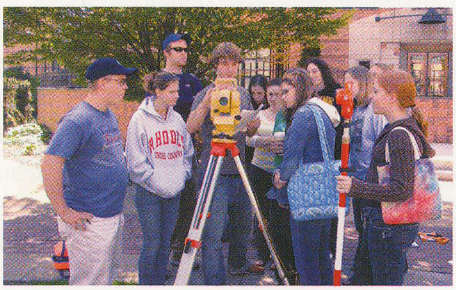

Figure 4. CGMA students learning how to use the laser transit at The College of Wooster in October 2005. Students collected points on Wooster's campus with the transit (as well as with handheld GPS units) and then plotted those points during the ArcGIS sessions. Although most of their projects do not require the use of a laser transit, this training is useful for those students who plan to work on archaeological projects.

Photo by Rebecca Schindler. Used by permission.

Figure 5. CGMA faculty and students collaborating in a breakout session at the midterm meeting of all campuses at The College of Wooster in October 2005. Typically at these meetings, we pair a faculty member with a subset of the students to work on a specific theoretical, methodological, or practical problem facing the project, such as how to design the variable of "chronology" such that calendar years and named periods can both be included as options. These sessions have been invaluable; on multiple occasions important new ideas or solutions for problems have come directly from the students.
Photo by Rebecca Schindler. Used by permission.

project alone, and so working together fruitfully (even if everyone is not in complete agreement) is a necessity if the project is to be productive and successful. Students rarely have the chance to observe this behind-the-scenes process. We expect them to apply these skills as they participate in the practicum on their campus, conducting a local survey project of their own design.

The practicum

At that point in the semester when students have been exposed to the fundamentals of both survey research and GIS software, and our expectations for their collaborations have been made clear, students at each of the four campuses are responsible for designing, implementing, and analyzing a survey of part of their campus or town. The projects themselves have varied widely. From 2003 to 2004, students at the College of Wooster surveyed two cemeteries, and Millsaps students carried out two projects: one Cultural Resource Management GIS of their campus and a survey of a Jewish cemetery in Jackson, Mississippi. Rhodes students completed an efficiency analysis of the distribution of faculty offices to the classrooms in which they teach, and tracked the performance venues of Elvis Presley in Memphis, Tennessee. DePauw University students surveyed a local cemetery (figure 6), and mapped the distribution and history of churches in Greencastle, Indiana (figure 7). The findings of these surveys are not as important as the methods; our primary goal is to have the students apply professionally and collaboratively the techniques they have learned.

By the end of the term, students merged their maps and databases in ArcGIS to produce some basic maps. In figure 7, 10-by-10-meter sample squares are visible as clusters on the aerial photograph. One of the initial questions being asked about this cemetery was the history of its spatial development. At this stage it became clear to the students that a 20-percent random sample was insufficient to address that question. This was a good lesson in how initial results sometimes require additional research to capture legible and meaningful patterns.

As facility with ArcGIS increased on the member campuses, students began to download and georeference aerial photos, topographic maps, and other materials common to GIS for archaeological surveys. They collected the geographic coordinates using GPS. A problem common to all the practica has been an inadequate amount of time during one term to collect enough information to map out and analyze patterns. Extending a particular practicum over multiple years might address this issue.

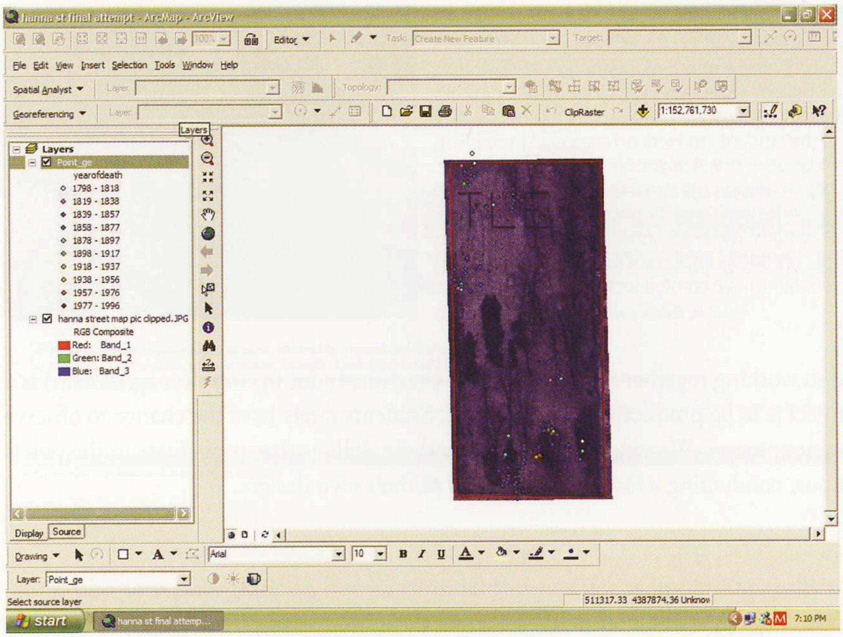

Figure 6. Student Practicum for DePauw University, 2003. Survey of the Hanna Street Cemetery.
USDA GeoSpatial Data Gateway.

The practicum has several stages, and throughout their experiences, the campus teams report weekly on their progress to their peers and instructor through the CDS. Though we break down the stages into distinct tasks for the sake of project management, we work on the practicum throughout the semester. Issues related to the practicum are interwoven into other segments of the class, and students apply their growing knowledge to their own practicum projects, which they complete by the end of the semester.

Stage 1: Formulate research questions, choose an area, and develop a survey strategy. Each group decides on particular social questions that they might be able to answer through the collection or recording of artifactual evidence. They then determine the limits of their survey region. The group also decides on a sampling strategy.

Stage 2: Develop a collection strategy and design a database. Groups decide on a collection strategy and design data sheets for each field as well as the entire computer database.

Stage 3: Conduct the survey. Students implement the survey they have designed using GPS units to collect locational data, and using their data sheets to collect attributes for the fields in their database (either in the field or using local archives and libraries). They then report back to the class on their field experience: what worked and what did not?

Stage 4: Map the results. After its data is collected and entered, each group creates a preliminary hand-drawn map of its survey area. We consider how to render topography, what physical structures require inclusion (e.g., buildings, trees, and other elements that may not be the object of inquiry), how those structures and the data points would best be symbolized, and how scale affects the impression of data patterns. The point of this exercise is to prompt the students to conceptualize and render their study area and their data in cartographic terms.

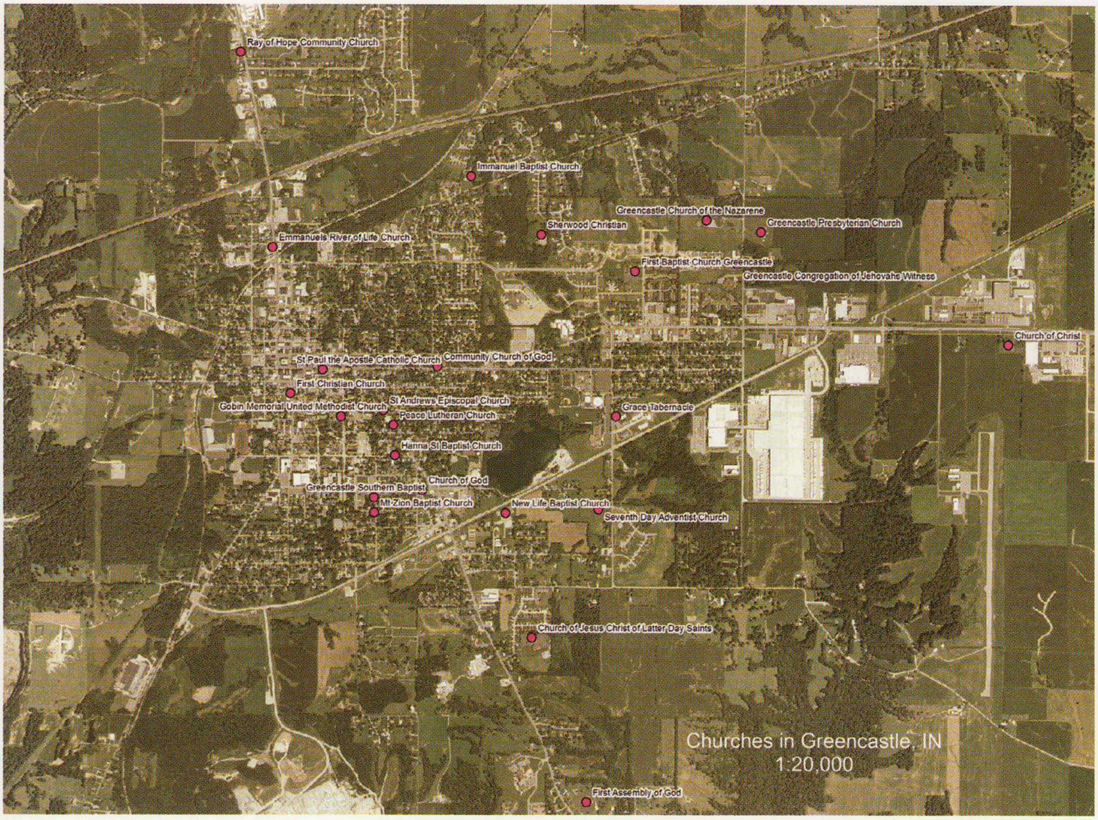

Figure 7. Student practicum for DePauw University, 2004. The sacred landscape of Greencastle.
USDA GeoSpatial Data Gateway.

Stage 5: Integrate the survey map and the database in a GIS. After their brief immersion with ArcGIS software during the midterm meeting, students begin to build a GIS for their survey. They note both the problems they encounter as well as new questions that come up during the process.

Stage 6: Visualize, explore, and analyze patterns and trends. Using GIS as both a tool and an environment, the students visualize, manipulate, explore, and test the data, progressing toward resolution of their initial research question(s) and eliciting additional questions.

Stage 7: Report on the process and principal results of the practicum. Because all archaeologists are responsible for disseminating their results, each group prepares an oral and written report for other members of the seminar. The report summarizes their practicum from start to finish. It must explain the research question, methods, and data (what are the significant patterns?), and offer preliminary interpretations of that data (what might the patterns mean in the context of understanding human activity, society, and the landscape?). This reporting is meant to model the principal modes of scholarly exchange, such as publications in journals and presentations at professional meetings.

Ultimately, this practicum accomplishes two goals: the technical goal of introducing undergraduates to GIS software, and the research goal of engaging students with the primary questions posed by archaeologists in landscape studies. Even though their field work is local and not based in the Mediterranean, the opportunity to conduct their own field survey work provides them with a context for working with others' findings in the remote Mediterranean. As a whole, the seminar and its practicum provide the methodological and theoretical background for students to continue with more advanced work in archaeology and GIS, either as part of the CGMA project or on other archaeological field projects.

Students who wish to maintain their involvement with CGMA and MAGIS beyond the seminar may do so through extracurricular activities throughout the year. In the spring, one or two of the seminar students are eligible for work-study at each institution, to continue some of their previously started research. Additionally, CGMA offers one summer research internship on each campus for students who have participated in the seminar. Students work at their home institutions or at DePauw, the home of the project, and they earn a stipend for their efforts.

Lessons learned

Teaching a multi-institutional course that contains a field component and an online learning component, as well as a connection to the ongoing construction of a major research database, has required us to carefully organize how we manage the course. ICC courses are not typical at our colleges, but it is clear that the students benefit from being part of a collaborative learning experience and having the exposure to multiple faculty members. Details and logistics have sorted themselves out over time; for example, now we recognize that having the faculty member with primary charge of the course for that year determine the assessment criteria is most efficient.[9] We have learned how to condense faculty training on GIS software so that they are able to apply it to their specific needs as quickly as possible. Our objective has never been to have students demonstrate mastery of a software package. Rather, each time we have a student spatially analyze his or her survey data and share the analyses with maps, we know our approach has been successful.

Since the fall of 2003, twenty-three students have completed the CGMA course, and they have collected and entered data on nearly 200 survey projects. One CGMA alumna is currently working as an intern in the DePauw University GIS Center, and several others have applied their knowledge from CGMA to field projects in North America and the Mediterranean. We are looking forward to testing and releasing the first version of MAGIS to the scholarly world, and continuing to synergize teaching and research of GIS and archaeology for our undergraduate students.

Acknowledgments

CGMA is funded by a grant from the Andrew W. Mellon Foundation and is supported by DePauw University, Millsaps College, Rhodes College, and The College of Wooster. The project is overseen by a board composed of survey archaeologists and technologists with expertise in databases and GIS. We would like to acknowledge and thank our coprincipal investigators: Michael Galaty (Millsaps College), P. Nick Kardulias (The College of Wooster), Kenny Morrell (Rhodes College), and all of the students at our schools who have helped advance the project. We would also like to thank M. Beth Wilkerson (DePauw University), our CGMA programmer, and Alexander Iliev (DePauw University), who has served as a student technology intern for two years (funded by the ITAP program at DePauw).

Notes

1. Each year more undergraduate courses in classical archaeology incorporate class sessions on GIS, but few offer hands-on training. Increasingly graduate programs in classical archaeology are including GIS as part of their curricula.
2. Sunoikisis, the Associated Colleges of the South (ACS) collaborative program in Classics. www.sunoikisis.org/.
3. ACS (Associated Colleges of the South) Archaeology Program. www.colleges.org/~turkey/.
4. For MAGIS, we have chosen open-source, nonproprietary software: MySQL (Structured Query Language) for the database, GRASS (Geographic Resources Analysis Support System) for the GIS and MapServer for the GIS Web interface. The development hardware is an Apple Macintosh Powerbook G4 running OS X; the server hardware is an Apple XServe with a 2-terabyte RAID array, running OS X. See www.magis.depauw.edu.
5. The Greater Mediterranean is both a cultural and geographic term. It includes areas incorporated within or with close connections to the civilizations centered in the Ancient Mediterranean, i.e., from Morocco to England in the West, and from the Persian Gulf to the Caucasus in the East. Any boundaries are to some extent arbitrary, and we may expand their reach in the future if necessary. MAGIS began with the GTOPO 30 data with 1 km resolution, but we are now implementing the much more detailed SRTM (Shuttle Radar Topography Mission) data, with 90 m resolution (SRTM) Data Server. srtm.csi.cgiar.org/).
6. Using the Spatial Search page (figure 1), the user is presented with graphical tools to poll the database for information. Users may select from the entire Mediterranean Basin or zoom in on a specific location. Individual survey boundaries are displayed as well as a list of projects in a given region. Various options are available for overlays and labels (e.g., names of survey projects, major ancient cities, rivers/lakes/streams, modern political districts, ancient regions). The Database Search page (figure 2) allows the user to query the database for a list of surveys that match given criteria, or browse by several fixed categories. The user may enter or select search criteria for any combination of the database fields, including Survey Name, Principal Investigators, Dates of Operation, Chronological Periods, Methodology, Environment, and Bibliography.
7. ACS Course Delivery System (CDS). cds.colleges.org.

8. We are using ESRI ArcGIS software with ArcView functionality and the Spatial Analysis extension. First we conduct a review of projection and coordinate systems (concepts already introduced in class), followed by essential setup features for ArcGIS, such as data frame properties and relative path names. Then we walk the students through the creation of a new ArcMap software document, covering raster and vector data types, layer superposition, importing publicly available data, creating new shapefiles and associated tables, and simple query and display operations.
9. These have included participation (in class, on the CDS discussion board, and "live" at the midterm workshop); group activities, (i.e., the practicum, which is graded in stages as students report on and post evidence of their progress to the CDS); individual student contributions to building MAGIS; and a take-home final exam. In assessing the practicum, as much weight is given to the process as to the final product, and the take-home final asks students to apply methods and theories of landscape archaeology discussed in the course to a particular case study.

References

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About the authors

Pedar W. Foss and **Rebecca K. Schindler** are both associate professors in the Department of Classical Studies at DePauw University in Greencastle, Indiana, where they teach courses in classical archaeology, Latin, and classical civilizations. Together they codirect the Collaboratory for GIS and Mediterranean Archaeology (CGMA). Over the last decade, they have used GIS in the context of their archaeological research: for Rebecca's work on Greek sanctuaries and the ancient landscape, and for Pedar's survey of the Elmali Basin in southwest Turkey.