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GIS IN NORTH AMERICAN ARCHAEOLOGY: A SUMMARY OF ACTIVITY FOR THE CAERE PROJECT

1. Introduction

The application of GIS technology to archaeological data and problems has a relatively long history in North America. Pomerantz (1981) probably makes the first reference to this technology in the archaeological literature, but there were other contemporary applications that were doing GIS or GIS-like things under different names, simply because the acronym of "GIS" was not widely known at the time. These applications employed digital elevation models (DEM), computer cartography linked with database management system (DBMS) for regional cultural resource management (CRM) purposes or as within-site spatial analysis tools, or they combined multiple environmental data layers as a basis for the analysis of prehistoric site locations (Kvamme 1995).

One impetus for the growth of archaeological GIS in North America was state-mandated databases for the management of cultural resources in huge tracts of government administered lands. GIS well fit this need with its linking of DBMS with cartographic capabilities. A second arena that influenced the early adoption of GIS by archaeologists also derives from CRM. Many agencies required models of archaeological distributions across broad areas, and GIS technology provided the only solution to this inherently difficult problem (see 2.7 *Archaeological Predictive Models*, below). Third, many archaeologists had already been introduced to computer technology during the early 1980s and so rapidly migrated to GIS when it became available. This was facilitated by an environmental orientation in American archaeology, derived from the cultural ecology school, which made GIS a particularly attractive means for the examination of sites in their natural setting with its ready suite of environmental data layers.

Two symposia on GIS in archaeology held at the annual meetings of the Society for American Archaeology, one in 1985 and a second in 1988, helped to promote wide adoption of the technology, especially the second one which resulted in the publication of *Interpreting Space: GIS and Archaeology* (Allen *et al.* 1990). This book more-or-less marks a transition point to relatively wide use of the technology in North America.

2. Review of the questionnaire data

The fifteen submitted questionnaires represent an interesting, and I believe representative, sampling of GIS activity by North American archaeologists. These applications generally parallel the principal domains of archaeological GIS use outlined by KVAMME (1989), ALDENDERFER (1996), and seen in such edited volumes as ALLEN *et al.* (1990) and LOCK and STANČIČ (1995). Yet, it is clear from the submitted questionnaires that certain domains are achieving greater attention, and entirely new ones are being explored. What follows is a summary of this work organized under a series of topical headings. In these sections, referenced works with a date refer to publications cited in the bibliography; referenced works without a date point to the authors of specific questionnaires submitted for this project, included below.

2.1 *Hardware and software*

GIS technology is now more accessible and affordable. There is great flexibility in hardware or platform configurations, and a number of excellent software packages exist. North American GIS applications are conducted on stand alone computers, on small networks, and in large corporate or state-supported network settings. The last generally occurs in government-supported CRM database contexts while the others are characteristic of the lone research professor or contracting archaeologist in small departmental or business settings. Pentium PC's are the most prevalent platform, followed by Unix (usually Sun) workstations and Macintosh computers. ArcInfo and ArcView software is most prevalent, but their use tends to be correlated with large database applications. IDRISI, MapInfo, and GRASS also are regularly cited, particularly in applications with problem-oriented research focuses. Because of the lack of GIS functionality in all computing domains of potential interest to archaeologists, North Americans frequently resort to other software to augment their capabilities. Statistical packages (SAS, SPSS, SPLUS) are most common, followed by specialized relational DBMS software, spreadsheets, and enhancement packages like Adobe Photoshop.

2.2 *Geographic distribution*

As might be expected, North American archaeological GIS projects are concentrated in that continent, with a heavy focus in the United States. Projects in Alaska, Arizona, Arkansas, Colorado, Maine, Minnesota, New Mexico, North Dakota, and South Dakota are represented. Two projects also occur in central Mexico. North Americans also work elsewhere around the globe. Several projects describe GIS efforts in Chile, France, Greece and Jordan.

2.3 *Scale of investigations*

GIS technology is extremely flexible and easily adapted to any spatial context. Consequently, the wide diversity of application areas illustrated by the questionnaires is not surprising. These questionnaires reveal that GIS is applied to regions as wide as a state (see questionnaires by Lockhart, Seamens, Johnson, Ossa), in smaller more localized regions like a river basin or watershed (e.g., Kantner, Madry, Palumbo, Maschner, Bampton, McClung de Tapia), or to a specific site and its environs (Kvamme, Romano, McClung de Tapia).

2.4 *Regional Database Management Systems (DBMS)*

Following patterns seen in the development of archaeological GIS in North America, most applications of the technology employ it as a means for handling and managing large regional databases. This practice is, in fact, promoted or even sponsored by various government agencies who require GIS driven databases for the management of cultural resource information. The GIS-driven database, of course, offers many advantages. Cartographic representation of the data may be instantly displayed, often revealing spatial relationships. When linked with a relational DBMS, searches may be conducted within the database engine using standard SQL or, conversely, initiated on the computer screen by making graphically-based spatial queries. The latter might be accomplished by pointing to a displayed site or by highlighting some subregion of the display; in either case appropriate data are retrieved from the database.

Applications that focus on the GIS-DBMS link follow two trajectories. The primary one sees a regional or state-wide database as an end goal, and typically results from state-sponsored support in CRM contexts (the questionnaire by Seamens is a good example of a state-wide database; Johnson, Lockhart and Ossa describe similar databases). In other words, it is the purpose of the GIS project to only establish a regional database. The second trajectory typically establishes a GIS database as a necessary first step required before actual research questions – the projected goals – may be addressed (see Madry, Palumbo, Bampton, Kantner, Romano, Maschner, McClung de Tapia, Kvamme). It should be noted that in this case, the database is an ancillary product of the research that in itself may be extremely useful.

Moving beyond regional DBMS applications it is the special capabilities and tools of GIS that has captured the attention and imagination of most archaeologists. What are these special capabilities and how are they being utilized by North American archaeologists? Although it is difficult to infer all the tools and approaches from the brief project descriptions, the questionnaires point to a number of common dimensions of GIS use in the analytical domain.

2.5 *Cartography*

GIS offers an excellent means to produce cartographic renderings of database information. Perhaps the strongest use of the technology for this purpose is by Romano, where GIS is used much like a CAD package to produce drawings of the ancient city plan of Corinth.

2.6 *Spatial Analysis*

Spatial analysis remains a strong goal and use of GIS in North America. This term captures a variety of goals, perspectives, and GIS techniques at many different scales. In most GIS-based spatial analyses, regardless of scale, the primary technique employed is that of simple data visualization. Through colour encoding, overlaying techniques, pseudo three-dimensional views, rotations, and other methods, the principal tactic is to make spatial patterns clear in order to delineate similarities and differences in archaeological distributions, associations and the like. In this sense, GIS has greatly altered how archaeologists typically pursue spatial investigations. Only a decade or so ago formal statistical analyses of the data were required. Now only a suitably designed graphic may be produced giving rise to the somewhat justified charge that GIS research promotes only the making of "pretty pictures". This is not to say that formal methods are not employed. Several of the questionnaires clearly indicate a heavy reliance on statistical testing and software (Lockhart, McClung de Tapia, Kvamme, Maschner, Bampton).

Although a number of the applications employ GIS for spatial analyses at the site level (Kvamme, Romano; see 2.10 *Within-Site Applications*, below), most such studies examine patterns of settlement and land use at the regional level. Regional studies typically focus on prehistoric patterns of settlement and land use and how these patterns change through time. Palumbo examines cultural differences in settlement in Jordan, while Kantner focuses on socio-political relationships in the American Southwest as reflected by ceramic distributions. Most studies, however, examine site or settlement distributions with respect to various environmental conditions in a region, a task greatly facilitated by GIS methodologies. In other words, these studies typically employ GIS to establish associations between environmental features and past settlement choices (Maschner, Johnson, McClung de Tapia, Lockhart, Palumbo). One special GIS area of application that builds on these methodologies lies in the area of what has been termed "predictive models of archaeological location."

2.7 *Archaeological predictive models*

Owing to the large tracts of government controlled lands in North America, and a general need to know the nature of archaeological distributions on those lands for management and planning purposes, certain GIS dependent methodologies were developed in the 1980s for making predictions about archaeological spatial distributions across regions (Kvamme 1989). These methods are based on: 1) establishing correlations between known archaeological sites in a region and various environmental features of the region; 2) developing environmentally-based predictions about where unknown sites might be located, typically through regression or discriminant function techniques; 3) mapping the predictions across the entire region through GIS; 4) testing the accuracy of the model mappings against known (and independent) site samples. In recent years this methodology and form of application has witnessed a resurgence of interest, probably due to better access to GIS, computing technology, and digital data sets. Three such projects are included in the questionnaires (Johnson, Lockhart, and Madry), with the project by Johnson presenting an effort that is almost beyond belief: archaeological predictive models at 30 m spatial resolution for the entire state of Minnesota (218,000 sq. km)!

2.8 *Cost-surfaces and viewsheds*

The cost-surface and viewshed tools of GIS have proven to be of great use to archaeologists in their attempts to understand and explain the past, and have generally offered many new insights. This circumstance is particularly true in European archaeology where these two methods have been frequently employed to get at prehistoric territoriality and cognition (see papers in Lock, Stančič 1995). Although occasionally applied by North American archaeologists (indeed, many of the pioneering papers were by North Americans), they remain much less used techniques. One likely reason for this is a fundamental difference between North American and European approaches to the past. The former places much more of an emphasis on the physical environment, while the latter dwells more on the social environment where cost-surface and viewshed-derived territories or cognitive spaces are consequently more important. It is interesting that Madry's study, which applies both, lies in France, although Maschner's Alaskan work makes extensive use of viewsheds.

2.9 *Temporal studies*

One aspect of the questionnaire sample that surprised me was the large interest in cultural change studies that explicitly identified a temporal dimension. This is an all too neglected area of previous GIS work in archaeology in spite of the discipline's unique time-depth. With this level of interest it is unfortunate that the technology for true four-dimensional or temporal GIS (x,y,z spatial coordinates plus a time coordinate, t) is not widely available. Most users simply hold archaeology and environmental data from different times in distinct two-dimensional layers, and cycle through the layers as needed.

The present sample of studies examines cultural differences across time, usually in settlement or land use patterns, in such diverse areas as Alaska (Maschner), Maine (Bampton), central Mexico (McClung de Tapia), Jordan (Palumbo), and in France (Madry).

2.10 *Within-site applications*

By far the great majority of archaeological GIS applications are at the regional level. State-wide cultural resource databases certainly exemplify this, but most research applications have had a preoccupation with regional settlement distributions. Yet, the potential of GIS for handling and managing within-site data sets, however diverse they may be and whether in raster or vector format, is enormous. Four of the submitted questionnaires describe within-site archaeological GIS databases, perhaps denoting a trend toward larger-scale applications. Romano summarizes his well-known work at Corinth that links diverse data sources and mappings of excavations, architecture, and topography. Kvamme employs GIS to manage and analyze the spatial distributions of some 27,000 surface lithics in a Colorado desert site, to investigate pattern and structure in a Paleoindian period bone bed of some 44,000 bones in the Great Plains, and to manage and merge various geophysical prospection data sets at fortified Plains Village Tradition sites in the Dakotas.

2.11 *Use of satellite remote sensing data*

A claim for the past decade or more in the GIS industry is that remotely sensed satellite data will constitute a primary source of information for regional databases. This seems to be increasingly realized in North American archaeology where satellite data is being employed more regularly. One use is to provide basic environmental data for a region, usually obtained through digital image classification methods applied to the multispectral data (a common capability of many GIS). Another use lies in regions without good base maps; in these areas satellite information can be employed for primary map construction. Projects by Madry and Maschner make heavy use of these data, largely to better understand environmental parameters.

2.12 *Special or unusual applications*

A few of the questionnaires revealed unusual applications of GIS that may point to future directions for this technology. Madry employs virtual reality (VR) methods to bring the viewer closer to the prehistoric Burgundy landscape of Iron Age times. This reflects a general growing interest in multimedia, well reflected by common presentations on the World Wide Web. Some post-processual viewpoints suggest that VR may bring the viewer a closer awareness of past lifeways. Kvamme utilizes GIS as a front end to manage diverse data sets obtained through geophysical prospection linked with traditional maps and aerial photography. Given the amount of geophysical prospection activity currently underway in archeology, and its increasing popularity, this could represent a major growth area of GIS use.

McClung de Tapia endeavours paleoenvironmental reconstruction through time in the Teotihuacan region of Mexico, by using physical-chemical analyses of soils, micro- and macro-botanical remains, radiocarbon dates, and GIS-based interpolation methods. Since most archaeological applications of GIS utilize modern or contemporary environmental data, this effort represents an important and all-too-neglected effort in this direction.

3. Future prospects: A comment on the questionnaires

A number of trends seen in the questionnaires and in recent publications strongly suggest future directions that archaeological GIS might take.

a) State-sponsored GIS-driven CRM databases will continue to grow in number and in size. The ready access to basic data and cartographics that these systems provide are simply too attractive for managers and planners to do without.

b) GIS will grow as a tool for the management of archaeological data at the site level. Complex excavation data may be linked with mapped surface finds, topography, aerial photography, and geophysical survey results to provide comprehensive management databases.

c) The use of remotely sensed satellite data as a primary data source for input to GIS will continue to expand, as more of these data sources became available and as the spatial resolution of these data continues to increase.

d) GIS-based archaeological predictive models will continue to be of importance in North America. As populations, urbanization, and development continue to expand, government managers and planners will increasingly turn to these models as effective and cost-saving planning tools for steering land-disturbing activities away from archaeologically sensitive regions.

e) With the growth of the Internet and the World Wide Web more and more spatial data sets and GIS-driven databases will go on-line and become widely available. When linked with other databases around the globe, with multimedia tools like animations, VR, and sound, truly powerful data sources and presentations will be realized.

The future will be an exciting place!

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RESULTS OF THE QUESTIONNAIRE GIS AND ARCHAEOLOGY

Title of the project: Casco Bay Environmental Archaeology Project.

Promoting institution: University of Southern Maine, Department of Geography-Anthropology.

Year of beginning: 1993.

Foreseen term: 10 years.

Geographic area: Casco Bay Estuary, Maine, USA.

Excavation area: Selected sites within Casco Bay Estuary Area.

Short description of the project: A long-term study of human-environment interactions within a single defined geographical region. Key questions to be asked include the nature of transformations attributable to human actions, the relationship between environmental parameters and human actions, and the development of methods for discerning cultural patterns using spatial analyses of archeological data. A key component of our work is developing public education strategies to enhance the value of the work, and the comprehension of its importance by the local community.

Hardware: PCs.

Software: PC ArcInfo, ArcView, IDRISI, SPSS, MapInfo.

Application of descriptive standards:

Application of Spatial Analysis: Distance and neighborhood operators used to classify regional ecology and paleoecology patterns. Database analysis used to determine temporal groupings of similar and dissimilar components of the archeological record.

Other important information: Recent addition of the federally-funded Casco Bay Estuary Environmental Assessment Project database to USM's resources, and the designation of USM as a state repository for GIS data greatly enhance our data resources to pursue this work. The development of a new GIS facility within the next twelve months will significantly enhance our analytical and data storage capacities.

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Title of the project: Mn/Model: Minnesota Archaeological Predictive Model.

Promoting institution: BRW, Inc., Minneapolis, Minnesota Department of Transportation, Minneapolis, Minnesota.

Year of beginning: 1995.

Foreseen term: 5 years.

Geographic area: State of Minnesota.

Excavation area: Not applicable.

Short description of the project: Computer models forecasting traffic patterns, demographics, real estate prices, and endangered species distributions are routinely used in highway route planning. Mn/Model was conceived as a means by which the Minnesota Department of Transportation could incorporate cultural resources considerations in the planning process as well. Mn/Model is a state-wide predictive model of prehistoric archaeological site distributions, designed as a tool for highway planners in order that archaeological sites may be avoided, thereby reducing costs and preserving the resource base. The project entailed setting up a state-wide GIS with as many as 120 environmental data layers, a 30 meter grid resolution, and 218,000 sq. km (over 515,000,000 grid cells). It also entailed putting together an archaeological database of all known sites in the state together with active field survey projects to randomly sample certain study regions in the state. The predictive models are being developed on a regional basis using random survey samples of archaeological sites, the GIS environmental database, and a logistic regression modeling technique. All models are tested with independent archaeological data and generally reveal high accuracy in performance.

Hardware: Sun workstations and Pentium PCs.

Software: ArcInfo and ArcView.

Application of descriptive standards: Each variable is rigorously defined in a standards book. All archaeological sites are similarly evaluated for their data quality.

Application of Spatial Analysis: Spatial sampling designs are employed and logistic regression discriminant functions.

Other important information:

Address: Craig M. Johnson, BRW, Inc., Thresher Square, 700 Third Street South, Minneapolis, MN 55415 USA; Tel: 612-370-0700.

www address: http://www.mnhs.org/prepast/mnshpo/pmncr/mnmodel/mnmodel.html

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Title of the project: Lobo Mesa Archaeological Project.

Promoting institution: University of California at Santa Barbara.

Year of beginning: 1995.

Foreseen term: Undefined (5 years?).

Geographic area: Southwestern United States.

Excavation area: Not applicable.

Short description of the project: The Lobo Mesa Archaeological Project consists of several phases. The first phase is the collection of all preexisting data on prehistoric Anasazi remains found within the project area, and the assembly of these data in a GIS. The second phase consists of the addition of environmental data to the GIS, including water, soils, topography, and geology. The third phase includes the selection of several sites from the study area for which preexisting ceramic collections exist. These collections will then be subjected to the detailed collection of ceramic compositional and microstylistic data, which will ultimately be included in the GIS. The resulting GIS will be subjected to a number of analyses related to the political and social relationships between prehistoric communities in the study area.

Hardware: Sun Sparc Stations and a digitizer.

Software: ArcInfo and ArcView.

Application of descriptive standards: Internal consistency; no other similar projects in the area are being conducted from which standards can be derived.

Application of Spatial Analysis: Various simple spatial statistics, cost-surface analyses, catchment analyses

Other important information:

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Title of the project: Sieber Canyon Archaeological Project.

Promoting institution: University of Arizona (until 1993), Boston University (1993+), US Bureau of Land Management, Grand Junction District.

Year of beginning: 1987.

Foreseen term: Indefinite.

Geographic area: Eastern Great Basin, USA.

Excavation area: Limited testing only.

Short description of the project: The Sieber Canyon Project was envisioned as a distributional or landscape archaeological approach toward a better understanding of hunter-gatherer locational behavior, within-site and intersite spatial relationships, site and activity structure, assemblage composition, technological factors, and other domains. Located in a remote and arid region of western Colorado, USA, this project makes use of surface mapping of abundant artifact distributions in this desert landscape. To date, approximately 27,000 artifacts have been mapped, including over 1,100 chipped and ground stone tools in a contiguous area of approximately six ha. With numerous flaking or tool manufacturing concentrations, activity, and work areas mapped, recent work has conducted magnetic survey to locate prehistoric hearths and place them within the context of these features. Virtually all of these data are held within a GIS, including a field-measured DEM at 4 m spatial resolution.

Hardware: Pentium PCs, Sun Sparc Stations, color inkjet printers, pen plotters, laserjet printers, scanners, digitizers.

Software: IDRISI, GRASS, custom software.

Application of descriptive standards: All variables are well-defined.

Application of Spatial Analysis: Extensive use, including experimental models of debitage fall-off densities, spatial t-tests for differences, tests for autocorrelation, EDA statistics.

Other important information: Results appear in Kvamme 1992, 1993, 1996, 1997.

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Title of the project: Jones-Miller Paleoindian Site.

Promoting institution: Boston University & Smithsonian Institution.

Year of beginning: 1997.

Foreseen term: 2 years.

Geographic area: Great Plains, USA.

Excavation area: 468 square meters.

Short description of the project: The Jones-Miller site represents a Hell Gap period (ca. 10,000 BP) paleoindian bison kill in the western Great Plains of Colorado, USA. Completely excavated during the 1970s by Dennis Stanford of the Smithsonian Institution, more than 44,000 bison bones and numerous stone and bone tools were recovered, with exact three-dimensional coordinates. This site offers a unique opportunity for the understanding of dense bison bone beds, and the spatial organization of butchering and other activities. GIS is being used for data exploration and visualization, to recognize patterns, trends, associations, and spatial relationships, and to test formal hypotheses.

Hardware: Pentium PCs, Sun Sparc Stations, color inkjet printers, pen plotters, Laserjet printers, scanners, digitizers.

Software: IDRISI and GRASS.

Application of descriptive standards: All variables are well-defined.

Application of Spatial Analysis: Extensive use, including EDA statistics, tests for clustering, dispersion, association, and tests for spatial autocorrelation.

Other important information:

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Title of the project: Plains Village Geophysical Prospection.

Promoting institution: Boston University, National Center for Preservation Technology and Training, US National Park Service.

Year of beginning: 1997.

Foreseen term: 2 years.

Geographic area: Great Plains, USA.

Excavation area: Limited testing only.

Short description of the project: This project focuses on the need for continuing advances in the incorporation of geophysical prospecting data sets within GIS databases, and the use of GIS and other tools to increase the potential and utility of these data. Fortified prehistoric Plains Village Tradition sites along the Middle Missouri River can yield excellent geophysical results in the form of numerous patterned geometries like fortification ditches, bastions, houses, middens, trackways, and plazas that are readily interpretable in mapped results. Combined with vegetation marks seen in aerial photographs, microtopographic indications, and surface artifact distributions, the potential for comprehensive remotely sensed databases is enormous.

This project focuses on magnetic, resistivity, conductivity, and some ground penetrating radar survey, and seeks to combine these data through multivariate statistical manipulation and color compositing overlays. The goal is to explore the richness of results that may be derived when utilized in combination and to better understand the structure and content of these sites.

Hardware: Pentium PCs, Sun Sparc Stations, color inkjet printers, pen plotters, Laserjet printers, scanners, digitizers.

Software: IDRISI and GRASS.

Application of descriptive standards: All variables are well-defined.

Application of Spatial Analysis: EDA statistics, multivariate methods, principal components analysis, extensive use of image processing methods.

Other important information: Results appear in these publications: Results appear in publications of KVAMME.

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Title of the project: Environmental Modeling and Analysis for Human Ecosystem and Settlement Pattern Research.

Promoting institution: Arkansas Archeological Survey.

Year of beginning: 1988.

Foreseen term: Long term.

Geographic area: State of Arkansas, USA.

Excavation area: To date 33,000 archeological sites and 3,200 archeological surveys statewide.

Short description of the project: The specific goals of the project are (1) to assemble and organize data on past and present environments, and (2) to provide research and analyses culminating in the development of digital models, which will be used to assess correlations between human land use patterns and land types.

Hardware: Unix-based Sun Microsystems.

Software: Informix (RDBMS), Geographic Resources Analysis Support System (GIS). Exploratory Data Analysis and Statistical Packages.

Application of descriptive standards:

Application of Spatial Analysis:

Other important information:

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Title of the project: Arroux River Project, Burgundy, France.

Promoting institution: Rutgers University and University of North Carolina at Chapel Hill.

Year of beginning: Research has been going on in the area since the mid 1970s, starting with Carole Crumley, of UNC. I started as a graduate student in 1978, and began the air photo interpretation, remote sensing, GIS, GPS, visualization, and other activities. The project activities are ongoing with Carole and her students doing archaeological work, and me and my students at Rutgers doing all the GIS/RS/GPS work.

Foreseen term: The idea is very long term interdisciplinary research, with no specific ending date. A group of researchers, graduate students, and others are working in the region in many different subject areas, and I try to put what I can into a GIS environment.

Geographic area: The Arroux River valley, Burgundy, France. An area of about 30 km (EW) by 70 km (NS), from Autun at the North to the confluence with the Rhone river at the South.

Excavation area: Many, including surface transects, small excavations around the area, major digs at Celtic hillforts and Gallo-Roman villa sites.

Short description of the project: The project is a long-term, interdisciplinary investigation into the relationship between cultures and the landscape over a 2,000 year period, from the Celtic Iron age to the present. Over 30 researchers and graduate students since the 1970s have conducted various interdisciplinary work (ecology, archaeology, historical studies, medievalists, fluvial geomorphologists, etc.) in the region. Carole Crumley started the archaeological work in the mid 1970s. I started the GIS/remote sensing work in 1978 with air photo analysis, then satellite remote sensing, GIS, GPS, and visualization. My primary interests have been (over time) analysis of archival 1940s air photos, digital image processing of satellite and airborne remote sensing data, predictive modeling of site locations of different periods, virtual reality, line-of-sight analysis of hillforts, digitizing of 1759 map data into the GIS, modeling ancient roadways, etc.

Hardware: Various, mostly Unix workstations, Sun and Silicon Graphics, with much visualization and modeling work in the Mac environment.

Software: Initially GRASS GIS, but we are using a variety of software, including ArcInfo, ArcView, ERDAS image processing, QTVR virtual reality, Photoshop, etc.

Application of descriptive standards: Lots, predictive modeling, road modeling, photo interpretation and digital enhancement, digitizing 1759 roads, digital image processing of thermal scanner and SPOT imagery, etc.

Application of Spatial Analysis:

Other important information: Check out our web page for a good overview of our work.

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Center home page: http://deathstar.rutgers.edu/

Personal page: http://deathstar.rutgers.edu/people/madry.html

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Title of the project: Remote Sensing and Geographic Information Systems for Archaeological and Paleo-landscape Research on the Lower Alaska Peninsula and Eastern Aleutian Islands.

Promoting institution: University of Wisconsin, Department of Anthropology.

Year of beginning: 1997.

Foreseen term: 3 years.

Geographic area: Southwest Alaska.

Excavation area:

Short description of the project: We have scanned 300 black and white 1:20,000 photos and constructed a 2 m DEM for over 600 sq. km. This DEM was combined with glacial and coastal geomorphology data to reconstruct the Aleutian shoreline over the last 12,000 years. We have integrated LANDSAT TM data, 1:60,000 color IR, and 1:63,000 stream and lake coverages. The ultimate goals are: 1) the evolution of Aleut settlement; 2) landscape and hunter-gatherer sedentism; 3) changes in the marine ecosystem; 4) model hunter-gatherer landscape choice.

Hardware: 1 Sun Ultra Sparc 2-3D w/ 256 Mb and 200 Gb, 1 Sun Sparc 4 w/128 Mb and 5 Gb, 1 Pentium pro 200 with 128 Mb and 4 Gb, 1 Pentium pro 2 (2 processors) with 256 Mb and 9 Gb.

Software: Various photogrammetric programs, ArcInfo, Imagine, SAS, Splus.

Application of descriptive standards: None.

Application of Spatial Analysis: ArcInfo, Splus.

Other important information: Write me if you want more data on the photogrammetric part of the project.

Address: Herbert Maschner, Department of Anthropology, University of Wisconsin, 5240 Social Sciences, Madison, WI 53706 USA.

E-mail: maschner@facstaff.wisc.edu

www address:

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Title of the project: Prehispanic Population and Natural Resources after the Fall of Teotihuacan: A Spatial Analysis of Archaeological Distributions.

Promoting institution: Instituto de Investigaciones Antropologicas, Universidad Nacional Autonoma de Mexico.

Year of beginning: 1991.

Foreseen term: 2000.

Geographic area: Basin of Mexico, Central Mexico.

Excavation area: Teotihuacan Valley, State of Mexico.

Short description of the project: Development of a spatially referenced database of all archaeological materials and results of physical-chemical analyses (including micro, macrobotanical and faunal remains) recovered from extensive excavations in caves occupied following the fall of Teotihuacan (carried out under direction of Linda Manzanilla). Analysis of spatial relations/associations of artifacts in domestic and ritual context.

Hardware: PC Pentium, digitizing tablet (summagraphics).

Software: ILWIS, Excel, JMP, IDRISI, MapInfo.

Application of descriptive standards: Frequencies of artifact types and other archaeological materials in separate layers; quantitative variables (physical-chemical analyses) in separate layers.

Application of Spatial Analysis: Overlays, datacrossing, and other traditional forms of visual analysis in GIS; cluster analysis, measures of association, spatial autocorrelation and correspondence analysis.

Other important information:

Address: Emily McClung de Tapia, Laboratorio de Paleoetnobotanica y Paleoambiente, Instituto de Investigaciones Antropologicas, Universidad Nacional Autonoma de Mexico, Circuito Exterior s/n, Ciudad Universitaria, Coyoacan 04510, México, Distrito Federal, Mexico.

E-mail: mcclung@servidor.unam.mx

www address: http://www.geocities.com/CapeCanaveral/3705/home.html

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Title of the project: Paleoenvironment of the Teotihuacan Region.

Promoting institution: Instituto de Investigaciones Antropologicas, Universidad Nacional Autonoma de Mexico.

Year of beginning: 1991.

Foreseen term: 1998.

Geographic area: Basin of Mexico, Central Mexico.

Excavation area: Teotihuacan Valley, State of Mexico.

Short description of the project: Reconstruction of paleoenvironmental conditions and modifications through time in the Teotihuacan region. Model development based on interpolations of data from physical-chemical analyses of soils, micro and macro-botanical remains, and radiocarbon dates from soil profiles.

Hardware: PC Pentium, digitizing tablet (summagraphics).

Software: ILWIS, Excel, JMP, IDRISI.

Application of descriptive standards: Quantitative characterization of vegetation and soil strata; variables registered as separate layers.

Application of Spatial Analysis: Interpolation of point data (kriging/trend surface analysis) to generate regional surfaces. Measurement of changes through time via map algebra techniques. Pattern detection through evaluation of spatial autocorrelation (site locations during different chronological phases) with respect to distributions of soils and vegetation.

Other important information:

Address: Emily McClung de Tapia, Laboratorio de Paleoetnobotanica y Paleoambiente, Instituto de Investigaciones Antropologicas, Universidad Nacional Autonoma de Mexico, Circuito Exterior s/n, Ciudad Universitaria, Coyoacan 04510, Mexico, Distrito Federal, MEXICO.

E-mail: mcclung@servidor.unam.mx

www address: http://www.geocities.com/CapeCanaveral/3705/home.html

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Title of the project: Archaeology of the Southernmost tip of South America.

Promoting institution: Southern Archaeology.

Year of beginning: 1989.

Foreseen term: 15 years +.

Geographic area: Tierra del Fuego.

Excavation area: Various.
Short description of the project: Title is descriptive.
Hardware: Day-to-day: PowerMac; Sun Sparc station and occasional PCs.
Software: MacGis, ArcInfo.
Application of descriptive standards:
Application of Spatial Analysis: Various.
Other important information:
Address: Paul Ossa, 3387 St Michael Dr, Palo Alto, CA, 94306 USA.
E-mail: p.ossa@ix.netcom.com
www address:

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Title of the project: The Wadi az-Zarqa-Wadi adh-Dhulayil Archaeological Survey Project.
Promoting institution: University of Rome, CNR, Yarmouk University (Irbid, Jordan).
Year of beginning: 1993.
Foreseen term: 2000.
Geographic area: Jordan (an area of 144 sq. km north-east of Amman).
Excavation area: Only soundings.
Short description of the project: The project aims at reconstructing settlement patterns and interactions between sedentary and nomadic occupations throughout the ages in an environmentally critical zone at the buffer between desert and cultivable areas in Jordan. Over 400 sites have already been identified, ranging in date from the Lower Paleolithic to the Late Ottoman period, and belonging to various categories of settlement. The study is also associated with an analysis of land use patterns, from archaeological and historical evidence, and from the ethnographic study of Bedouin and peasant groups living in the area today.
Hardware: Infograph workstation, 2 Pentium 100 Mhz processors, 4 Gb HD, CD-Rom writer and reader.
Software: Windows NT, ArcView 3.0, G-Sys 3.2.
Application of descriptive standards:
Application of Spatial Analysis:
Other important information: GIS is being used for two main purposes: organization of the survey information (text, databases, graphic, and photographic) and for spatial analysis purposes. In particular, relationships between settlements and their landscapes and environment will be investigated.
Address: Gaetano Palumbo, 1200 Getty Center Drive, Suite 700, Los Angeles, CA 90049-1684 USA.
E-mail: gpalumbo@getty.edu
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Title of the project: Corinth Computer Project.

Promoting institution: The University of Pennsylvania Museum of Archaeology and Anthropology.

Year of beginning: 1988.

Foreseen term: Fieldwork finishing 1997. 10 year field project (summers) and 10 year laboratory project September-May.

Geographic area: Corinthia, Greece.

Excavation area: Corinth Excavations, American School of Classical Studies at Athens.

Short description of the project: A computerized topographical and architectural survey of the Roman city and landscape of Corinth. The original objectives included the study of the nature of the city planning process during the Roman period at Corinth; to gain a more precise idea of the order of accuracy of the Roman surveyor; and to create a highly accurate, computer generated map of the ancient city, whereby one could discriminate and study the successive chronological phases of the city's development. Over the course of the ten years of the project the nature of the research has evolved from a fairly straightforward consideration of the location and orientation of the excavated roadways of the Roman colony, to a more complex topographical and architectural consideration of various elements of the colony, including the rural as well as the urban aspects of planning and settlement. The project now utilizes a number of different methodologies, simultaneously, in the overall study of the ancient city. One of these methods is the use of GIS in the study of the rural landscape of the Corinthia which is helping in the determination of the original rural landscape assignments of land by the colonists of the Roman city.

Hardware: PC based systems (both field and laboratory computers).

Software: AutoCAD, IDRISI, MapInfo, Softdesk Engineering software, survey software MAP (Sokkisha).

Application of descriptive standards: Definition of principles of ancient architectural survey and design in the landscape.

Application of Spatial Analysis: Area studies of regions of the Corinthia with respect to systems of centuriation of the Roman colonists at Corinth. Area studies of systems of Greek land planning in the regions close to the city of Corinth. Study of systems of road networks through the Corinthia, between cities and ports as well as historically attested towns and sanctuaries.

Other important information: The project is also including information from the city of Corinth from chronological periods other than Roman, specifically Archaic and Classical Greek, Hellenistic, Late Roman, Byzantine, Frankish, Venetian, Turkish and modern.

Address: David Gilman Romano, Ph.D., Mediterranean Section, The University of Pennsylvania Museum of Archaeology and Anthropology, Thirty-Third and Spruce Streets, Philadelphia, PA 19104-6324 USA; Tel: (215) 898-4437; Fax: (215) 573-2906.

E-mail: dromano@sas.upenn.edu

www address: http://ccat.sas.upenn.edu/~dromano/corinth.html

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Title of the project: New Mexico Cultural Resource Information System (NMCRIS).

Promoting institution: State of New Mexico, Office of Cultural Affairs, Historic Preservation Division, Archeological Records Management Section (ARMS).

Year of beginning: 1978.

Foreseen term: Permanent.

Geographic area: State of New Mexico (121,666 sq. mi.).

Excavation area: Not applicable (this is a survey database, excavation records and collections are curated and linked to database, however).

Short description of the project: The New Mexico Office of Cultural Affairs, Historic Preservation Division, maintains an inventory of all recorded archeological sites and investigations in New Mexico. The program responsible for maintaining this inventory is known as the Archeological Records Management Section (ARMS). In cooperation with the Museum of New Mexico, the Historic Preservation Division maintains a second office located in the Laboratory of Anthropology (LOA) for ARMS.

ARMS is the official state clearing house and repository for archeological records. The program is responsible for administering, managing, and preserving records pertaining to archeological properties in the State of New Mexico. ARMS has been in operation since the late 1970s, when computerization was undertaken to manage the tremendous volume of archeological records housed at the LOA. With the financial support of the Historic Preservation Division (then called the State Planning Office), the Museum of New Mexico created an automated database known as the Archeological Records Management System. Between 1978 and 1993, data derived from over 70 years of archeological research was automated and has served as the primary index to the many reports, research notes, forms, maps, and other documentation relating to over 120,000 archeological sites and 50,000 inventory and excavation projects in New Mexico. The database also provided a link to many archeological collections of the Museum of New Mexico, including the Archeological Repository Collection (i.e., bulk artifact collections), and various study collections created since the Lab's beginnings in the 1930s.

The Historic Preservation Division took over administrative control of ARMS from the Museum in 1985 and, in 1993, replaced the ARMS database with a more comprehensive system known as the New Mexico Cultural Resource Information System (NMCRIS). All existing archeological data were converted to the new information system, but the system was expanded to also integrate records pertaining to New Mexico's historic architecture and traditional cultural properties, and to serve the needs of a broader user community that includes industry as well as government and researchers. NMCRIS is based on modern relational database technology in a multi-user operating environment (Oracle RDBMS, Unix), and efforts are currently underway to integrate geographic information system (GIS, ArcInfo) capabilities.

The NMCRIS database may be accessed locally at the Laboratory of Anthropology, or at remote locations via modem or the Internet, providing on-line information exchange to scholars, nonprofit groups, archeological contractors, federal and state agencies, universities, and other organizations. An individual user account is required to access the on-line database query facility.

Cooperative data-sharing agreements with most state and federal land managing agencies provide financial support for the program and allow NMCRIS to cross lines of ownership and tie together all levels of government in an integrated statewide system of archeological data collection, management, and distribution. NMCRIS provides information to both government and private entities so that cultural resources may be considered in early stages of project planning, and damage to archaeological resources can be minimized. With NMCRIS, developers using public lands may be able to avoid some of the delays and expense that frequently accompanies archeological clearance efforts, and sites can be avoided entirely rather than excavated. The GIS capabilities of NMCRIS will also enable land managers to develop predictive capabilities regarding archeological site density and visibility, and use that information to advise developers on project locations throughout the state.

Hardware: Digital Equipment Corp. AlphaServer 2100, two 190 Mhz Alpha Processors, 192 MB memory, 10 Gb mass storage.

Software: Digital Unix OS, Oracle RDBMS v.7, ArcInfo v.7, ArcView V.3.

Application of descriptive standards: NMCRIS descriptive standards concern archeological survey and survey recording of sites.

Application of Spatial Analysis: This is a mainly management-oriented database used by historic preservation professionals, government planners and land managers, and archeological consultants. We also supply archeological data, including geospatial data, to researchers, mostly for conducting regional archeological overviews in New Mexico.

Other important information:

Address: Tim Seaman, Program Manager, Archaeological Records Management Section (ARMS), New Mexico Historic Preservation Division, 228 East Palace Ave., Santa Fe, NM 87501 USA; Tel: (505) 827-6347 x531/ 827-6497.

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ABSTRACT

Fifteen projects, running in a variety of hardware and software environments, are reviewed from throughout the United States and Mexico; work in other parts of the world by North Americans is also represented. Most applications occur at the regional level and represent either state sponsored archaeological management databases or research databases. Most employ GIS to manage regional data queries and visualization tasks; others focus more analytically on patterns of prehistoric settlement and land use at the regional level, with predictive models of archaeological location a management expression that relies heavily on research and analysis. Large interest is also shown in comprehensive within-site databases. Remotely sensed satellite data are being employed to construct base maps at the regional level while geophysical information is being incorporated in within-site databases. Although cost-surfaces and viewshed studies receive relatively little focus, there seems to be large interest in multitemporal studies that compare cultural differences and settlement patterns across the fourth dimension. The linkage of GIS with virtual reality and the increasing importance of the World Wide Web point to future directions the technology will take.