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PRAGIS: a test case for a web-based archaeological GIS

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ABSTRACT

Archaeology, like many disciplines, has employed GIS as a tool which allows a diversity of new research agendas, from predictive site modeling to the combination of spatial datasets once too cumbersome to be handled in entirety. With the explosion of web mapping applications over the past decade, the opportunity now exists to bring these capabilities, once requiring specialized education and software, to the entire archaeological community. The Puuc Region Archaeological Geographic Information System (PRAGIS) is a methodological foray into providing basic spatial analysis to professionals regardless of their computer mapping experience. With the combination of datasets pertaining to site location, landforms, modern features, recent land use patterns, as well as several basemaps, it is intended that this type of program will provide the intermediary functionality between the current options of basic static site visualization or a full suite of spatial tools, along with a corresponding internet database. http://egis.artsci.uc.edu/PRAGIS/

1. Introduction

As archaeology is a field inherently concerned with locating sites within a landscape, GIS has offered a perfect opportunity to allow the rapid mapping and dissemination of site and settlement pattern information. Digital geodatabases allow the accumulation of vast amounts of information which can be readily accessed with simple tools, such as overlay, or utilized in spatial analysis. One of the most daunting tasks in approaching any archaeological project is understanding how various elements relate, as well as the extent of work done by prior investigators. Such problems are greatly ameliorated by the compilation of information within a single resource that allows users to compare known relationships and develop future directions for research in the area. Though GIS systems offer the capability to compile many sources of information into a single source, which can be referenced on demand for basic data prior, during, and after a study, they have traditionally been restricted in access to only a few users. The now commonplace nature of web-based mapping applications offers the opportunity to bring GIS out of the realm of limited user groups and into the field of archaeology as a whole.

1.1. GIS and archaeology

Digital mapping developed as an archaeological tool slowly, starting first with specialists working in conjunction with archaeologists and later with a select few archaeologists learning all of the necessary methods. It was in this environment that many of the cornerstones of GIS applications in archaeology were developed, such as viewshed analysis (Lake et al., 1998; Wheatley, 1995), regional settlement pattern analysis (Kvamme, 1989), and predictive site modeling (Kvamme, 1999). Increased usage of GIS by archaeologists can be seen in the number of texts that introduce the topic to new or old professionals (eg. Conolly and Lake, 2010; Gillings and Wheatley, 2005; Renfrew and Bahn, 2012; Westcott and Brandon, 2005; Wheatley and Gillings, 2005). During a survey of 140 archaeologists in the late 1990s it was found that over 90% of the respondents utilized a GIS in their work (Gourad, 1999). It should be noted that Gourad's survey was conducted online with the intention of reaching those archaeologists most likely to utilize GIS.

The combination of an increase in general computer proficiency coupled with more user friendly application interfaces has allowed GIS to move from the purview of specialists into the hands of any archaeologist willing to devote the time to learning a new skill. Common products used include both open source software such as GRASS or Oxford Archaeology's release of gvSIG, and private software packages such as ESRI's ArcGIS. Unfortunately, ESRI's software, the more intuitive of the programs listed, has a high institutional price tag that can make it a divisive investment potentially precluding its inclusion for smaller archaeological projects. Even after acquiring the software capability, obtaining access or knowledge of the appropriate use of the information can be a challenge for those not accustomed to working with spatial data.

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Some archaeological projects have incorporated GIS development and analysis as part of their project design, but the information available from such work is typically only in the form of static maps or visualizations. Some projects which have prioritized GIS do provide the ability to download their data for personal use in addition to the formal presentation of maps prepared by the project itself (eg. Belli, 2010; Hammond, 2003). A small number of institutions have established centers for the collection, analysis, and redistribution of archaeological data (e.g. AERA, 2011; CAMEL, 2010). While such data sources offer valuable opportunities to increase a project's resources, they do not provide a universal system available to the archaeological community as a whole.

1.2. Web mapping/Web GIS and archaeology

Within the past twenty years, the way most people conceptualize and consume spatial information has been revolutionized. Where it was once common to have a static map displaying locations over a base of imagery, land surface classification, or hypsography, now a user often expects to have the ability to vary the scale, type of location data displayed, as well as base layer to overview the data. Web-based mapping officially began in 1993 with the release of PARC map viewer by the Xerox Corporation, but it was the exponential growth of internet usage and companies such as MapQuest and Google that turned the technology into an everyday tool for many in countries well served by internet access (Fu and Sun, 2011). Availability of high resolution satellite imagery through Google Earth brought an unprecedented opportunity for archaeological projects to engage in thorough prospection prior to ever setting foot in the field (Klokočník and Kostelecký́ý, 2010). Such access has also led some researchers to obtain data directly by digitizing structures from this imagery for further analysis (Sadr and Rodier, 2012). Though the benefit offered by imagery of this quality is enormous, the web offers greater capabilities for knowledge dissemination and interaction that provide an opportunity for spatial data availability currently underserved by any existing application.

Archaeological data has begun to make its way onto the web through both existing media as well as new applications. Google Earth provides every user with the ability to create data additions in the form of .kml and .kmz files which may be overlayed to the imagery within that program. Potential users only need to have the free program installed on their computers, and they can view these layers over the high resolution, multi-temporal imagery. Projects such as the Egypt Exploration Society's Delta Survey (2012) or the Electronic Atlas of Ancient Maya Sites (Witschey and Brown, 2012) present compiled information for hundreds, if not thousands, of sites and make them viewable within Google Earth. The EES Delta Survey also provides information about the site, its preservation status, and photos from the ground or of notable artifacts, while the Maya database displays rank dependent rendering to better understand site distribution and complexity.

There have been advancements working to bring archaeological information onto the web through mapping applications. An ongoing project called MAGIS, Mediterranean Archaeology GIS, presents a map based search option, but the resulting data are text based webpages which link to data about the individual projects within the database (Foss and Schindler, 2011). The Middle Eastern Geodatabase for Antiquities (MEGA – Jordan) is a $1 million project headed by the Getty Conservation Institute, and is a major leap forward in web-based dispersal of archaeological data. The system's primary focus is on the documentation of sites in a readily available format for risk assessment and monitoring purposes (Getty Conservation Institute, 2008). MEGA involved the digitization of antiquities records, and the building of its geodatabase in addition to the creation of a web viewer application capable of display and interactive selection of the more than 10,000 Jordanian archaeological sites (Getty Conservation Institute, 2011; Kennedy, 2010). Designed both for professionals as well as amateurs, sites are displayed over Google's high resolution satellite imagery as well as other Google basemaps, and the application allows a variety of search functions.

Though there is a wealth of information quickly available through MEGA, the system remains only a searchable database. This leaves space for further development of web mapping for archaeology that PRAGIS is a test case to fill. Similar to MEGA, there exists a native geodatabase containing site information as well as several different search options, but PRAGIS brings some of the functionality typically found only in a traditional GIS environment into a publicly available web-mapping application.

1.3. Region of study

The Puuc Region of the Yucatan, Mexico has been the subject of archaeological exploration for almost 2 centuries and professional archaeological investigation for about 90 years. This time depth has led to many sources with information regarding sites. Knowing how these works interrelate can often be challenging, and when dealing with sites that have been called by different names, amalgamated with other sites, or assigned to geographic locations with widely varying degrees of accuracy, the opportunity for error greatly increases. Understanding the regional distribution of archaeological sites can be challenging, and has long relied on the accurate publication of all known locations within a single source. This presents an inevitable dilemma where information can quickly become obsolete, and any error made in the publication is likely to be reproduced before a revised edition can be released.

Several scholars have published known sites within the Puuc such as Garza and Kurjack (1980) and Dunning (1992), but both exhibit the limitations of printed material mentioned above. Clifford T. Brown and Walter R. T. Witschey compiled a GIS for all Maya sites (Witschey and Brown http://mayagis.smv.org/) which they make partially available through a .kmz file that can be used in Google Earth. They offer to run analysis, but all queries must be submitted with the results to be provided upon completion. Unless a person has a prior background working with GIS they may be unaware of the range of possible queries. Further, at least for the Puuc region, this dataset has not been checked to verify site locations and eliminate numerous duplications. Though it is very useful, this dataset and its presentation could greatly limit the flexibility of researchers to investigate the data or pose questions of importance for many projects.

The Puuc is a region without well-defined boundaries (i.e., its boundaries vary considerably based on the sources and specific attributes under study, such as physiography or ancient architecture). In order to provide a definitive boundary for the GIS, four adjacent 1:50,000 topographic maps were selected to delimit the study area. The maps are part of the 1 to 50,000 series available from INEGI which cover most of Mexico. Though the Puuc region extends both to the south and east, no sites were included in the database beyond the joined map boundaries, and other data were clipped at this boundary.

2. Structure and development

Data were compiled and tools developed using ArcMap 10.1 with most information being stored within a single geodatabase. In an attempt to decrease server response times, data are fundamentally separated into two groups; active objects and viewable layers. Web services are published using ArcGIS Server 10.0 hosted on the EGIS server within the Department of Geography at the University of Cincinnati.