Spacing Archaeological Sites: An Application of the Geographical Information System to Philippine Archaeology

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Abstract

This paper is a critical review of the National Museum's current archaeological data management system. It explored the use of a Geographic Information System, specifically ArcView 3.3, for archaeological data management. This is a pressing concern due to the continuous growth in the number of materials and information on Philippine archaeology. The study took advantage of the current site list database of the National Museum which runs in Microsoft Access. These records were used to create a GIS-based site distribution map and an analysis of sites in Cagayan Valley. GIS proved to be better equipped to handle archaeological data. A site distribution map enables spatial analysis and reveals patterns that may lead to a deeper understanding of a community or system which is impossible to detect if information is displayed only in tabular form, just like in the case of the National Museum's database. The assessment also revealed gaps and inconsistencies in the data logged by researchers. The model opened new avenues and opportunities for further research utilising spatial patterning and analysis. Recommendations on additional site information that must be recorded by researchers were made to improve the number and quality of analysis that may be done.

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Introduction

This article will focus on the results of the GIS based distribution map of archaeological sites in Luzon that was created using the National Museum's site list database. The distribution map is one of the many possible applications of GIS to Philippine Archaeology. This article will discuss the gaps of the National Museum of the Philippines' existing database, highlight the advantages of GIS in handling spatial data, and list recommendations for further GIS related efforts of the National Museum. Through this comprehensive assessment of the Museum's site list database, this article can be a good reference for future computer-based initiatives by the Museum. It will also set the foundation for future GIS based endeavours both by the National Museum and the UP Archaeological Studies Program by producing a working model with archaeological sites plotted on geo-referenced maps of Luzon.

The law through Republic Act 4846 mandates the protection and preservation of Philippine cultural properties, which include the archaeological heritage. The archaeological heritage is the record of our people's culture and is a source of history, inspiration and knowledge. As such, their protection and preservation are embodied in the Philippine Constitution, which mandates the government to adequately protect and manage these important aspects of the cultural resources (Ronquillo 1992). The National Museum's Archaeology Division, through its Records Section, is continuously thinking of innovative ways to manage all of its archaeological data and has done a good job of digitising a number of its paper-based records and putting it in a database.

Extensive literature exists about the advantages of GIS in archaeological work, both for data management and spatial analysis. Aldenderfer and Maschner's "Anthropology, Space, and Geographic Information Systems" (1996), is a seminal work featuring articles on how GIS has been embraced by archaeology as a tool for recording, data management and analysis. The technology has become an invaluable tool in the archaeological research process and has been used extensively in the western world. On the other hand, the Philippines has yet to fully maximise its use (Mijares 2003). GIS has been gaining popularity in archaeology worldwide. Yet, there have been limited resources documenting how it has been used by the National Museum and the results of the experience.

This assessment identified two problems to be addressed.

Archaeological sites and related data continue to grow in number making data management an immediate concern for Philippine archaeologists. There is a need for an efficient system that can store, display and facilitate easy retrieval and sharing of spatial data. To date, the National Museum has a database of its archaeological sites with selected attributes running in Microsoft Access® (Figure 1). It has limitations for a database in an archaeological environment mainly for two reasons. First, it will not scale to the needs of archaeological research. Archaeological research is a collaborative effort of the different disciplines whose data include maps from geography, soil and topography attributes from geology, and even satellite images. Second, archaeology deals with information that consists of spatial and temporal dimensions best represented through maps. Microsoft Access® is not equipped to handle this.

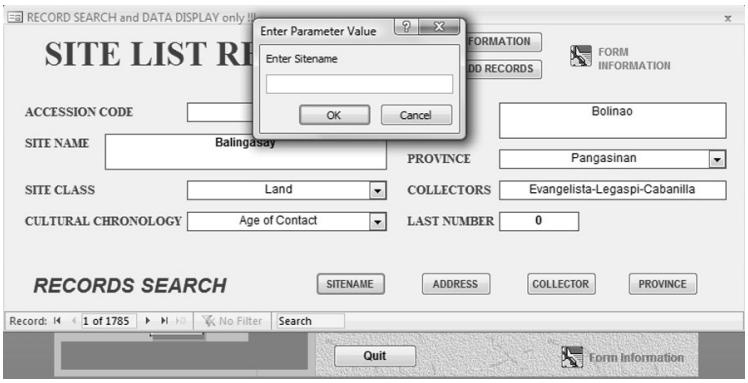

Figure 1. National Museum's Site List Database runs on Microsoft Access®. A search on an archaeological site will reveal information such as accession code, site class, cultural chronology, address, province and collectors.

The second problem is a result of the first, that is, by using a system that cannot handle and display spatial information, a lot of opportunities for spatial analysis are missed. The information that is currently recorded can offer much more to research if displayed from another format such as maps. The layering capabilities of GIS through thematic maps can offer new insights vis-à-vis looking at information independently or in a tabular form.

GIS and Archaeology

GIS stands for Geographic Information System, "a sophisticated database management system designed for the acquisition, manipulation, visualisation, management, and display of spatially referenced (or

geographic) data" (Aldenderfer and Maschner 1996:4). It is an "integrated and integrating technology that provides a suit of tools that help understand spatial information" (Conolly and Lake 2006:11). It is computer dependent and has three important components—hardware, software and people. It can process inquiries and statistical analysis, as well as provide visualisation of spatial data (Sebillo *et al.* 2003). "Trends, patterns, and relationships are so easily visualised, particularly when data are presented in map form" (Kvamme 1999:154). Its uses are so varied but Kvamme (1989, cited in Aldenderfer and Maschner 1996) subsumes these under five broad themes – regional data management, management of remotely sensed data, regional environmental analysis, simulation and locational modeling.

The Spatial Database

The spatial database is one of the GIS subsystems wherein data is organised into layers. GIS uses the concept of "thematic mapping" where a collection of thematic maps describe a certain aspect of the area being studied. The location of an object and its other attributes are recorded distinctly. How does a spatial database differ from a traditional database? The difference lies in the structure. While a spatial database and a traditional map may contain the same information, traditional maps present all information in one sheet. It is usually a complex visualisation as opposed to a spatial database which shows "a set of specific thematic layers" (Wheatley and Gillings 2002:25). Take for example the traditional map. It holds so much information in one flat sheet, which may or may not be needed for the research at hand. It is also static with no provision for the additional of new data. Thematic mapping layers the different information which may be turned on or off as needed during the research process (Figure 2).

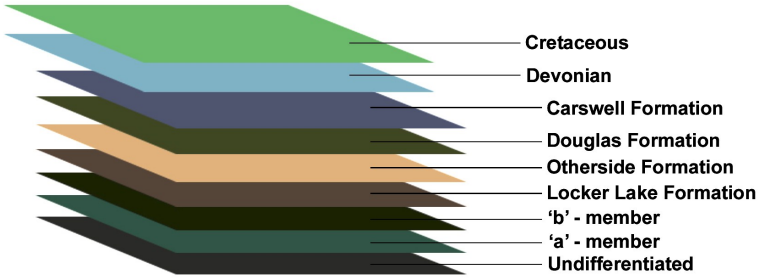

Figure 2. If a traditional map of Geologic timescale were to be interpreted using a spatial database, each timescale will correspond to one layer or theme (some call it coverage or image). During the research process, each layer may be turned on or off as needed.

Once the GIS layers are ready, it is possible to determine spatial relationships within multiple layers and it is easy to determine patterns that would otherwise be difficult to detect if the data were presented in tables. By combining different map layers, a new map can be produced "providing potential insight into relationships between elements on different themes" (Conolly and Lake 2006:17).

How archaeologists can benefit from the technology

GIS can help archaeologists:

1. Organise existing data, promote data consistency, and facilitate accurate data entry and data collection.
2. Integrate different data formats into one central data store.
3. Provide easy access to data sources and user-friendly mapping tools for team members.
4. Explore distributions and densities of specific artefact, feature, and architectural types.
5. Analyse artefact groups and their relationships to possible activity.
6. Document and manage environmental impacts and modern-day threats to the site.

GIS provides a dynamic and flexible environment where archaeologists can "integrate, express, analyse and explore the full range of data, both spatial and attribute" (Wheatley and Gillings 2002:18) (Figure 3).

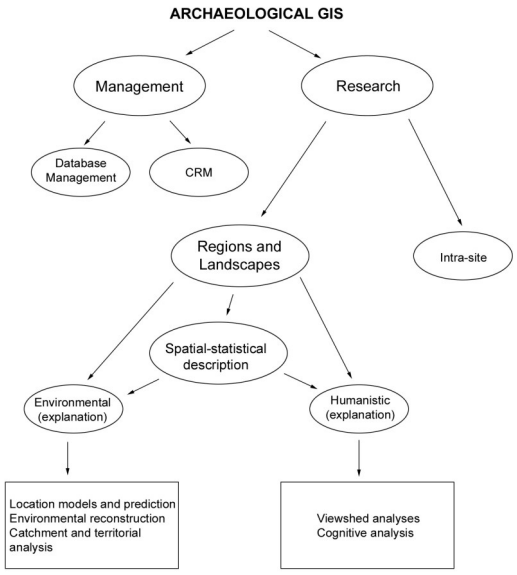

Figure 3. A suggested structure for the current applications of GIS within archaeology. (after Wheatley and Gillings 2002, Fig. 2.1)

Methodology

Designing the Geographic Information System

There is a great deal of analysis involved in designing a system. For Howard and MacEachren (1996), system design goes through three levels of analysis—conceptual, operational and implementation. Koussoulakou and Stylianidis (1999), used GIS to visualise archaeological finds and came up with a set of guide questions for the three levels, in the context of archaeological research. This paper follows the structure of the said design with additional guide questions.

The process starts at the conceptual level where the goals are defined and guide questions are prepared to identify the needs of the user. At the operational level, processes are identified based on the goals listed. For the implementation level, the user interface is taken into consideration and how the user will interact with the system (Koussoulakou and Stylianidis 1999).

Questions addressed at the Conceptual Level: Needs Analysis

1. Who will use the system?

The system was developed primarily for the archaeologists and researchers of the National Museum. It is expected to assist them as they study various patterns of site distribution in space and time.

2. What need/s is/are met by the system?

The system will primarily provide the National Museum with a site distribution map of the Luzon area to aid them in their various researches on patterns of spatial distribution of archaeological sites. It will provide the museum with a good data management system that is appropriate for the discipline by having the capacity to handle several forms of data that is usually produced by archaeological research like maps, illustrations, photographs, satellite images, statistical data and the like. Since the system is GIS based, combining the different themes available can produce new maps that can inspire new research agendas. It can aid in survey and prospecting by providing a visual of site distribution, making it possible to come up with inferences on the presence or absence of archaeological sites in an area. The system will also provide the National Museum with geo-referenced digital maps depicting different natural variables like soil type, slope, distance to water, among others, for future GIS projects.

3. What should be the result of working with the system?

It should facilitate the understanding of a site's structure and offer interpretations on the distribution of sites in Luzon. The system should also simplify the retrieval of data. It will provide the museum with a repository of archaeological data that can visualise the spatio-temporal attributes of the sites through maps. It can be used as a tool for survey and prospecting, by studying the distribution map produced by the system to come up with inferences on the presence or absence of sites.

4. How are the needs of the users met by the system?

The system enables the recording of the coordinates of the sites, querying, easy retrieval of data and cartographic visualisations.

Operational Level: These are the system's functions or the operations that can be carried out for spatial data, the temporal attributes of the sites and the thematic attributes of the sites. These operations should help achieve the goals in the conceptual level.

1. Spatial Data
   - Query and display the location of an object/site by visualising the point in a map
   - Query and display information such as accession number, site name, address, collector, cultural chronology, site characteristics and site class

2. Temporal Attributes of the Site
   - Query and display the site's cultural chronology (e.g. Palaeolithic, Neolithic, Metal Age, Contact Period)
   - Thematic Attributes of the Site

3. Hide/unhide thematic maps composed mostly of natural variables (slope, river system, soil, land cover, and others)
   - Query and display the characteristics of every natural variable
   - Implementation Level: The User Interface lists everything that the user will see and experience to be able to use the system and view the information.

Data Collection and Generation

After setting the directions of the research through the questions listed above, data for the system was collected. The main data for the GIS were obtained from the current "Site List" database of the National Museum, running on Microsoft Access. The records were extracted and

saved as an excel file, to simplify the viewing and copying of needed records. Only the excavated and surveyed archaeological sites in the Luzon area were extracted. The locations of these sites and areas were checked to make sure that they are recorded with an address up to the barangay level. Those whose addresses are not enough to be plotted on the barangay map, or could not be found in the list were double checked in www.fallingrain.com, an online database of all places in the world, with their corresponding longitude and latitude, or with the records section of the National Museum.

The main concern of this assessment is the visualisation of the sites' distribution. Sites with known municipality at the least were included and placed on the map. Aside from the location of every site, other information that are important for archaeological research were extracted for the GIS, like the cultural chronology, name of collectors, site characteristics, and others.

To fill-in the missing Cultural Chronology for some Cagayan sites, the area whose data will be sampled for further analysis, the report of Dr. Armand B. Mijares, a former National Museum researcher and faculty of the University of the Philippines—Archaeological Studies Program who conducted several excavations in the area was made as reference. Gaps in the records of the Lal-lo Cagayan sites were researched from "Unearthing Prehistory: The Archaeology of Northeastern Luzon, Philippine Islands" (2007). The report of Ronquillo and Santiago (1977) of the National Museum on the caves of Peñablanca offered detailed information on the description of almost all listed sites in Peñablanca, Cagayan.

The sources of the natural variables which constituted most of the different themes included detailed maps of soil, river systems, roads, land cover, slope, and geology of the entire study area. The 1:50,000 map of every province, digitised up to the barangay level, constituted the other themes. The entire topographic map of Cagayan, the area identified by this assessment for modeling was scanned and geo-referenced as another theme.

Almost all of the digital maps were provided by the organisation AnthroWatch. Topography maps of the Cagayan Region were purchased from the National Mapping and Resource Information Authority (NAMRIA).

Development of the Prototype

All the available digital maps were geo-referenced and set-up with Luzon 1911 as datum since most of the map series published by NAMRIA use the Luzon datum. As soon as all the digital maps have been added as themes in ArcView 3.3, every archaeological site and surveyed area was plotted on the map, based on its barangay address. Sites with only the municipality recorded were plotted at the center of the whole municipality.

ArcView 3.3 was used for the prototype despite the newer version which was ArcGIS because the author had no access to a licensed version of the latter and the prototype did not demand the power and functionalities of a more advanced version. AnthroWatch (an NGO), generously lent the author a licensed ArcView 3.3 and its capabilities served the purpose of the intended output. No other database was created to record the artefacts. The prototype was only concerned in plotting the archaeological sites.

Each site appears as a point on the map with links to other information (Figure 4). Every site has a provision for the following information, with the last five as additional fields to the original National Museum database:

Accession Number
Site Name
Address
Cultural Chronology
Collectors
Site Class

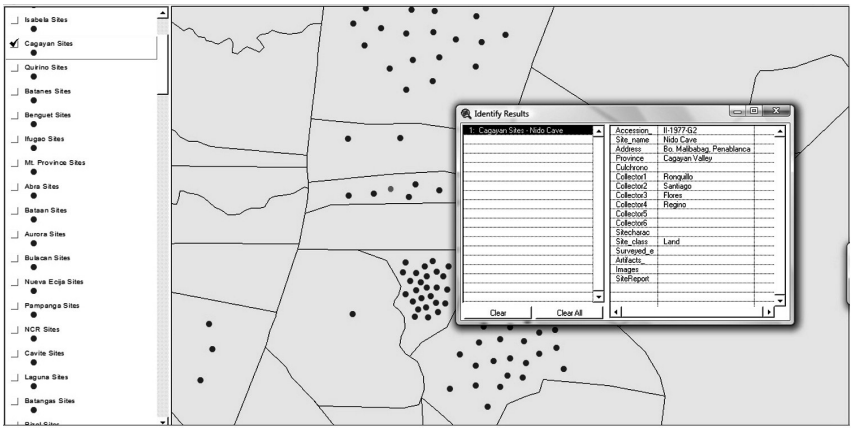

Figure 4. Each site appears as a point on the map with links to other information such as accession number, site name, address, and cultural chronology, among others.

Site Characteristics
Surveyed or Excavated
Artefacts
Images
Site Report

The final output is a distribution map of the sites in Luzon (Figure 5). Aside from a site distribution map per province, maps were combined to show a regional site distribution map (Figures 6 and 7).

To demonstrate one research possibility with the distribution map, the sites in the Cagayan region were selected to compare site and non-site locations. Cagayan is a good sample because of the high occurrences of excavated and surveyed sites. There are more than 200 recorded sites in the area.

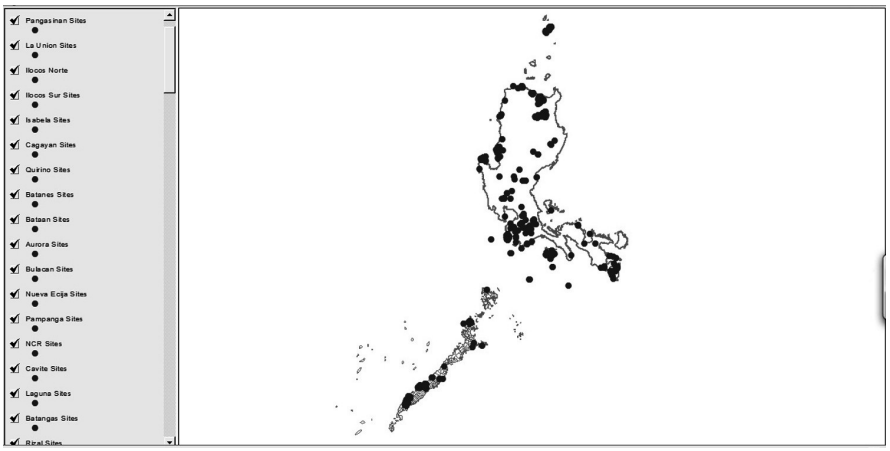

Figure 5. Site distribution map of Luzon, Philippines.

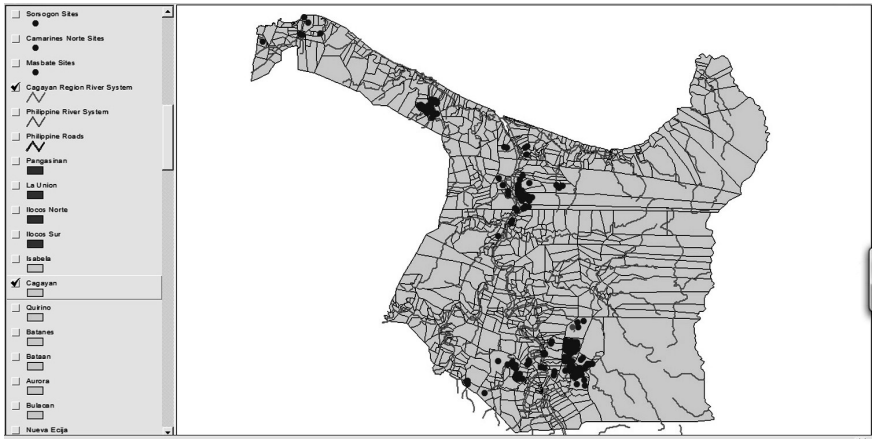

Figure 6. Site distribution map of Region Two, Cagayan Valley, Philippines.

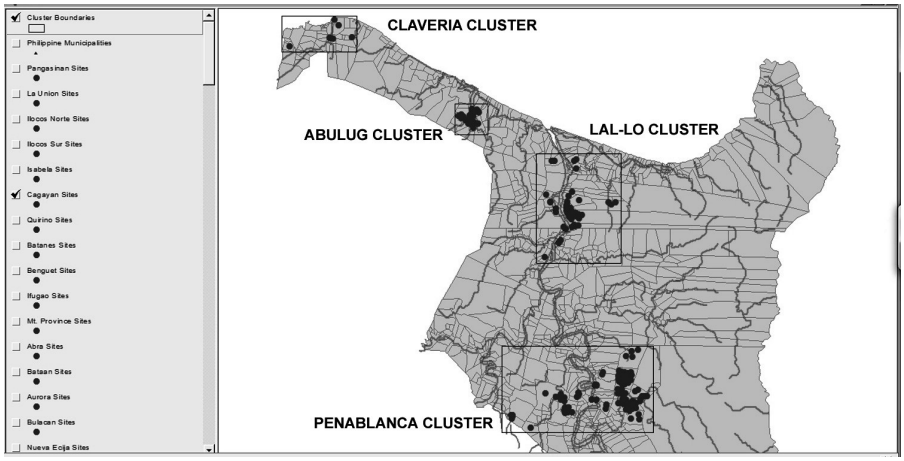

Figure 7. GIS makes it easy to visualise the distribution of archaeological sites in an area such as the clusters of sites in the Cagayan Valley Region. The spatial database revealed four clusters of sites in the region – Claveria, Abulug, Lal-lo and Peñablanca.

The analysis consisted basically of a synthesis of the conditions of sites per cultural chronology based on the following variables—soil type and slope. Proximity to water was another consideration but was not included anymore since all the sites in the study were near a water source, specifically the Cagayan River.

Discussion

GIS for Data Management of Philippine Archaeological Records

The Philippine archaeological record consists of data on the material and cultural remains of past cultures multiplied by the area of the entire country. Owing to the fact that culture history is made up of different factors one can just imagine the layers and layers of data that have to be stored and organised for future archaeological research.

This assessment is a pioneering effort to use Geographical Information System to manage archaeological data from the National Museum. Archaeological record-keeping involves different set of tools and methodology because of the nature of archaeological data. It is not enough to simply be able to store and retrieve information from a database. Archaeological data has a spatial dimension, which opens up various possibilities in research and offers more information if made accessible. It is also a multi-disciplinary field, where collaborations from different disciplines are often needed for a more accurate interpretation of

data. This collaboration means that different data in different forms from different disciplines have to be accommodated in the recordkeeping.

The system created for this assessment displays information that are available from the current National Museum Access database but is scalable to accommodate future records. Fields for more site related data in the future can be easily added into the system. The records that can be displayed at the moment are very basic but adequate enough to lay the foundation for a good data management system. The researcher can query and retrieve the following information provided by the National Museum records: Accession Number, Site Name, Site Address, Cultural Chronology, Collectors, and Site Class. It can also accommodate images such as satellite maps and it is possible to link to .pdf and .doc files for full reports.

Aside from the usual list and information in tabular form the output of the whole data management system takes the form of a distribution map, which is another important tool in archaeology. The system visualises, through maps, the distribution of sites across Luzon, providing opportunities for spatial analysis. Layers of different natural variables (topography, soil type, soil, river system, etc.), visualised through maps provide additional information in the analysis of archaeological sites.

Gaps and Recommendations

With the limitation of available data from the Access database of the National Museum, the result of the GIS-based list of archaeological sites in Luzon did not fully satisfy two important tasks in archaeological recordkeeping (1) recording context and (2) providing redundancy (Peregrine 2001). By the end of the excavation the entire context of an artefact has been destroyed. Thus, information about its context is never enough to aid future researchers. This problem may be addressed by linking more reports to every site in the future and adding more database fields with information that may help recreate the context of every site and artefact. Field researchers should diligently fill-out all the information required in the survey and excavation forms. Site reports, which are one of the important sources of information for the data management system, should be thoroughly prepared with as much detail. In the current system, the following fields were added, even if there are no data to populate it yet.

1. Site Characteristics – This is a short description of the site

2. Longitude and Latitude – These are the exact coordinates of the site.
3. Link to an image – This can be a link to a photo of the site or an important / unique artefact.
4. Link to Site Report – For a complete report about the site, nothing beats the original site report which can be linked as a .pdf file or .doc file.
5. Excavated or Surveyed only – In the Access database of the National Museum, sites were not tagged if they were surveyed or surveyed and eventually excavated. List of unexcavated sites could prove useful since these areas have high potential of yielding artefacts. There might be plans of excavating them in the future.
6. Elevation – The elevation is especially important for caves. Paper-based contour maps of the National Museum will have to be consulted individually to extract this information.
7. Survey forms, inventory of excavated sites, site excavation report and other paper-based records should be reviewed to extract this information.

It should also be noted that full names of the collectors or researchers should be recorded in the system to avoid confusion in the future. The current National Museum Database lists only the surnames. It will also add to the efficiency of the system, wherein users who know only the first name of the collector can still do a relevant search.

Redundancy in the recording of important information will be achieved as layers upon layers of data are added to the system through the years. At this point, more information should be extracted from the site reports. As early as this initial attempt, the quality and relevance of data recorded should already be noted. The more relevant data are added to the system, the more depth in the analysis may be expected. The goal of every data management effort in archaeology is to record the most information possible so that other archaeologists may reconstruct the area excavated.

The Distribution Map of Luzon

Distribution maps plot against a given space or map the exact position of sites or artefacts thus allowing visual and statistical analyses to be performed. As basic as it may seem, distribution maps carry with it a wealth of information about an archaeological data in relation to its space or to other sites and/or artefacts surrounding it. Despite the early awareness that location is integral in archaeological research spatial

`studies in archaeology was never systematised until recently. Instead, archaeologists borrowed methods from other disciplines such as botany, geography, ecology and economics, to analyse data derived from their distribution maps. Several efforts on spatial analysis start off with a distribution map.

The distribution map produced by this assessment is a visualisation of the positions of the different sites in Luzon against a standard map and other relevant variables visualised through maps. Since some of the sites have incomplete addresses and there were no GPS coordinates in the source database, some sites were plotted based on their municipality. This means that all sites are in their correct municipalities at the least, but not accurately plotted in their exact point in the municipality. Nevertheless, at a scale of at least 1:50,000, this visualisation method is good enough to demonstrate existence of archaeological patterns and clusters. Some of the spatial analyses that may be applied in this map in the future are point pattern analysis, regression analysis, trend surface analysis and spatial autocorrelation.

Discerning patterns of association among distributions is not as simple as it seems. Aside from the visual approach to data, there is also the statistical approach. Objective statistical tests are usually employed to "detect and verify the existence of patterns". Archaeologists also rely on statistics to objectively measure the strength of these relationships. Sometimes the concern is not whether there is a pattern, but the strength of these patterns. Visualisation and quantitative analysis of spatial data are, therefore, complementary.

What is the relevance of these patterns and clusters in archaeology? There are two types of distribution maps – one, it can show the distribution of archaeological sites and second, the distribution of artefacts on a given space. In this assessment, the output is a distribution map of archaeological sites in the Luzon area. Some observations that can be explored are: If they are clustered in an area what are the characteristics of that area that make sites abound there? Is it influenced by natural conditions or is it mere coincidence that survey and excavations have been arbitrarily made there? If proven to be influenced by natural factors, are these factors also present in other areas? Sites may also be present in other areas with similar conditions.

Gaps and Recommendations

The major difficulties in the creation of the distribution map were

the incomplete recording of address names for some sites and unrecorded GPS coordinates. With the accessibility of mapping technologies such as Google Earth, it is now possible to precisely plot the areas of the archaeological sites with minimal effort and can then be imported to GIS. This can be done for sites without coordinates to complete the records. For future excavations, the Museum should look into the strict recording of GPS coordinates for the areas being surveyed or excavated. This is all the more accurate than street and barangay names.

The Different Themes

The power and complexity of results that can be produced by a GIS depend on the available themes that represent different natural and cultural variables important for analysis. The more variables, the more analysis can be made. In this research, only natural variables were added due to the limitation of available data. Nevertheless, the output is already a good prototype for it presented a lot of the information sitting on the database of the National Museum in another perspective (Figure 8).

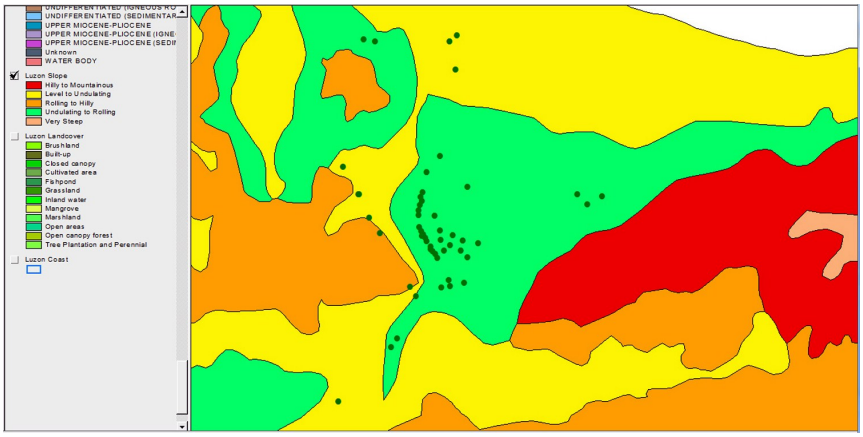

Figure 8. With the "Luzon Slope" theme visible, researchers can see the level of slope where a site is located. Luzon slopes are classified as Hilly to Mountainous, Level to Undulating, Rolling to Hilly, Undulating to Rolling and Very Steep.

The different themes in this research can offer some of the following information relevant to archaeological research:

- Topography – shows contour of an area; Van Leussen (1993) in Kvamme (1999) notes that "characteristics of terrain probably influenced the size and shape of territories".
- Slope – as slope increases, it becomes more difficult to traverse; the degree of steepness significantly affects the possibility of human

occupation and the reasons for such choice of terrain

- River Systems – boundaries may have been 'attracted' to natural features like rivers and ridge lines; since rivers are a source of water, nearby areas may be archaeologically sensitive
- Soil – soil conditions can show potential of area for agriculture; it can also dictate the speed and degree of decay of materials in contact with it;
- Geology – it contextualises the site in terms of the geologic time scale; it can determine the types of rocks that abound in the area; for Palaeolithic sites with stone tools, this information is important.

Gaps and Recommendations

This research relied on the digitised maps available from AnthroWatch. The National Museum, though complete in their site maps, still rely on paper-based maps. For the Cagayan Region, it was difficult to procure even paper-based topographic maps from NAMRIA. Some sheets were out of stock. It would benefit the National Museum if they can digitise and geo-reference different maps for future use. Natural variables which can be visualised through maps include geomorphology, ecological border distance, topography, hydrology and geology. Since human behavior has been identified to be patterned with respect to its natural and social environments efforts should be given to producing themes based on cultural and social variables also. Cultural variables may include subsistence systems, migration path, transportation systems and previous settlements. These maps will be challenging to develop but can be a work in progress as more information are gathered from different researches.

The quality and accuracy of the different maps are also a concern. Maps from NAMRIA from which most of the digitised and geo-referenced maps were based, are mostly a result of survey and recording way back in the 1950s. The ideal set-up is to have a collection of different versions of a map. Recent satellite imageries are now very easy to download with practically no cost. Having these images in the databank is practical for comparisons especially with the meandering movement of rivers.

Conclusion

In this study, an attempt was made to examine the possible applications of Geographical Information System in Philippine Archaeology by using it as a data management system, eventually

producing a distribution map of archaeological sites in Luzon. A case study of the Cagayan Province sites was further explored to come up with a simple prospecting guide for probable archaeologically sensitive areas in Cagayan and to visualise the trends and clustering of sites in the area.

GIS has become a standard tool in archaeology and has contributed much in the advancement of the field. GIS will do its work of opening up possibilities and opportunities for spatial analysis, but it will demand an equal effort from archaeologists to provide quality data. It will require some changes in the way Philippine archaeologists collect, record and manage their data. First and foremost is the importance of always recording a site's coordinates on the map.

In line with this, the assessment noted some gaps in the current National Museum Access database, which has to be addressed to keep up with the current technology and to execute effective archaeological research. The following observations should be noted:

1. The recorded data on the individual sites are not substantial. Though there will eventually be a link to the entire site report, key information about the sites should be recorded in the database through individual fields to make the information easy to search.
2. Field and excavation forms should be conscientiously filled-up by every researcher since this is the primary source of data that is entered in the database.
3. The recording of the exact coordinates of all archaeological sites should become a standard procedure if GIS is to be used in the long-term management of archaeological data.
4. Guidelines should be formulated in the naming of sites to avoid subjective and vague site names.
5. By virtue of Executive Order 45, PRS92 was made the standard reference system for all surveying and mapping activities in the Philippines. It is now mandated that all maps should be based on this reference system. All data in the National Museum database should therefore be converted accordingly.

Some of the gaps were brought about by the changing times and technology. For instance, if noting the longitude and latitude were not crucial before the advent of GIS, now, coordinates are required if one were to use GIS in any archaeological endeavour. National Museum researchers mark sites on paper-based topographic maps and use the same map to determine the longitude and latitude not in the context of

using it for GIS. Their methods of recording depend on the current tools available and convenient during the time of survey or excavation. Sixty years ago, researchers never thought that data would be digitised, tagged and made searchable through a database. Now, all recording should have this end in mind.

GIS proved to be an effective tool in visualising archaeological data into maps as shown by the distribution map created for Luzon. By combining the different spatial variables, relationships or associations can be identified by the researcher, which might stimulate questions for future research, and studies as demonstrated by the prospecting tool for Cagayan. "GIS would greatly enhance the ability to analyse relationships such as co-occurrence and proximity within acquired data. The GIS would also allow the creation of valuable derived information, products that represent a synthesis of multiple factors" (McGwire *et al.* 1996:98).

This study also created a good model for further GIS efforts by the National Museum. It can scale to the needs of archaeological research in terms of the types of data that can be integrated and the themes and tables for most of the provinces in Luzon have already been set-up.

The most important realisation in this whole exercise is that the quality and accuracy of data recorded will dictate the quality of analysis that can be conducted and the extent of analysis that can be made. The result of any study is only as good as the data available. Thus, there is a need for a collective conscious effort to gather and record archaeological data from the field conscientiously. For the long-term use of GIS, different natural and cultural variables should be continuously digitised to enable deeper understanding of sites.

As all powerful computer applications, GIS is only a tool for research and the site distribution model that was created along with the article is not the end itself. It is a tool to further discover the history and culture of people and places. A GIS is dynamic and certain layers of data are added as new research reveals new information. The end all objective for creating a GIS is not coming up with the system but learning more about the world that we live in.

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