Remote Sensing and GIS Study at Beikthano (Vishnu City)

San Shwe[1]

Department of Archaeology, University of Yangon

Abstract

The Pyus, a Tibeto-Burman people, came down into Myanmar from the North-East and settled first at a site that would later be called Beikthano (Vishnu) in Ayeyawady valley. Beikthano developed gradually, from a small village to a city, in the course of successive stages of evolution. This complex development involved numerous inputs, from Indians, Khmers and Mons. Such inputs intertwined with the Pyus' indigenous beliefs, customs and ways of life, formulating what would ultimately be known as the Pyus' defining religious beliefs, arts and crafts, as well as trade, commerce patterns and techniques needed for the construction and building of cities. Beikthano located on trade routes between India and China, sustained trade relations with South and North India, Yunan, Funan and the Mon's regions. These interactions enabled Beikthano to advance its economic fortunes. But such achievements were largely local in their broader impact. Beikthano remained the target of frequent assaults from neighboring city states and other states. This was the case in the 3rd and early 5th centuries, when Beikthano experienced two great attacks from its neighbors. These attacks did not prove fatal, and Beikthano remained a significant site in the early historic development of the Pyus from the early first millennium A.D. well into the thirteenth century. This paper briefly describes the archaeology of Beikthano, and how the information recorded in archaeological site inventories can be used in predictive modelling using GIS.

Key words: Beikthano, GIS, Remote Sensing, Vishnu

1.   Introduction

Archaeologists have been using Aerial prospecting and photography since just after World War One to locate buried structure, roads, and other features of ancient landscapes. Several archaeologists who served in that air war noticed strange circles and square patterns from the air. After the war they returned to these locations to find that these were actually archaeological sites, ancient roads, and other features of buried ancient landscapes. Satellite images also look like the Aerial photos. Archaeological sites, ancient roads, and other features of buried ancient landscapes are seen in those images. (Box 1999: 34) According to the archaeological evidence got from Aerial photos & Satellite images, the archaeologists can excavate in that excellent sites and then completely carry out predictive modelling of those sites.

GIS, a tool specifically designed to accommodate space, has become more attractive, especially as space is again becoming more important in archaeological thought. Kvamme traces the earliest true use of GIS in archaeology to the Southwest United States and the Granite Reef project, 1979-1982. Various data layers for 32000 square Kilometres using a cell size of 3.4 square Kilometres were mapped to create a weighted environmental suitability model for early subsistence and desert travel. Earlier precursors of GIS in archaeology identified by Kvamme (1995) include computer mapping of artefacts recorded in a database by Effland (1979), digital elevation models for visualization in the early 1980's and computer simulations by Zimmerman (1977), and Chadwick (1978). Much current research in GIS and archaeology revolves around ways to incorporate landscape as well as spatial archaeology. Mapping and analysing the social historical structures, physical structures, and boundaries of a landscape at various scales becomes practical with the use of GIS. The archaeologists have attempted to uncover how past peoples perceived the landscape is through view shed analysis, especially in relation to monuments. GIS calculates a view shed or line of sight map by using a given point(s) (representing the viewer) and a digital elevation model (representing the topography). The

---

[1] San Shwe, Archaeology Department, University of Yangon

computer then calculates the area that is visible from that point, or points in the case of cumulative view shed analysis (White 2002: 9-18).

2.   Aims and Objectives

This project is intended to the creation and maintenance of digital resources related to aerial photography, satellite and airborne remote sensing and archaeological interpretations made from such data sources,. The suggestions offered in this project are aimed at ensuring that these digital resources can be re-used, and therefore details are given about archiving digital data with the Archaeology Data. The hardware and software used to process manage and analyse aerial photographs and remotely sensed imagery has evolved a great deal since first introduced.

This project is intended to provide information about how to interpret photographs or remotely sensed images, how to take aerial photographic images, or how to process such images once you have obtained them. General advice about locating and re- using original data sources is offered. Throughout, this project refers to existing standards for documenting and cataloguing digital resources, and to the rich existing archaeological literature.

The aims of this project are more generic: to inform readers of the importance of good documentation practices rather than recommending how those resources should be documented. Finally, as this project deals with remotely collected data, ground- based geophysical data and archaeological data are marked on maps for entry into the GIS database. Using GIS software, we can pan and zoom across a particular area of interest, and identify features on the various map layers. The identify results window displays the attributes for archaeological site stored in the Site File database. Archaeological field data collected with Global Positioning System (GPS) receivers can be directly integrated into GIS, increasing the degree of accuracy when recording archaeological site and other cultural features. All the features on the map were recorded using GPS receivers during an archaeological survey.

3.   General Consideration of Beikthano Archaeological Site

Beikthano (Lat. 20° 00' N and Long. 95° 23' E) is situated to the north of Kokkogwa, 16.09 kilometers on the northwest of Taungdwingyi, Magwe District. Other Pyu cities include Halin, to the north of Beikthano and Sriksetra to its south. Beikthano also was built between Taungdwingyi valley and the Yin valley, near the pace track of the Yin and Yanpe streams. L. de. Beylie' explored Beikthano in 1907. Later on, during 1958-1963, 25 sites, during 1996-99, 10 sites, during 2002, 1 site, during 2003, 10 sites, during 2008, 8 sites and during 2009-2010, 5 sites -- were excavated by the Archaeology Department, Ministry of Culture (Hudson 2004: 117) (Aung Thaw 1968:4,vii) (Moore 2007: 156) (*Report on BTO* **6,7,8,9,10**) (Thein Lwin 2003: 1-14) (Thein Lwin 2010: 5-16) (Aye Mi Sein 2009: 4-8). The following table shows the period of work devoted to each site and the respective excavators who took charge of the field-work:-

Table 1 The Excavation at Beikthano

Site No.	Period	Director
KKG-1 and 2	11 June 1959 to 1 September 1959	U Aung Thaw
KKG-3 and 4	11 December 1959 to 4 March 1960	U Aung Thaw & U Myint Aung
KKG-5,6,7 and 8	27 August 1960 to 29 September 1960	U Myint Aung & U Bo Kay
KKG-9 and 10	15 January 1961 to 20 March 1961	U Sein Maung Oo
KKG-11,12 & 13	22 January 1962 to 19 March 1962	U Myint Aung
KKG-14 to 25	14 October 1962 to 3 April 1963	U Myint Aung
BTO-1 to 10	1995-1999	U Kyaw Oo Lwin & U Myo Min Kyaw
BTO-11	2002	U Nyein Lwin
BTO-12 to 21	1 June 2003 to September 2003	U Thein Lwin
BTO-22 to 26	2 February 2008 to 9 April 2008	Daw Aye Mi Sein
BTO-27 to 29	2008	U Naing Win
BTO-30 to 34	19 October 2009 to 23 March 2010	U Thein Lwin

The 25 sites excavated during 1958-1963, were serially numbered KKG 1 to KKG 25, as the area falls within the present village-tract of Kokkogwa. During 1995 - 2010, 34 sites were further excavated here. These were serially numbered BTO 1 to BTO 34, short hand for Beikthano. Two names for one archaeological site are confusing. Above excavated mounds are grouped by type below (San Shwe 2006: 275) ((Aung Thaw 1968: 7-56) (Stargardt 1990: 152-4) (*Report on BTO* 6,7,8,9,10) (Thein Lwin 2003: 2-16) (Thein Lwin 2010: 5-16) (Aye Mi Sein 2009: 4-8). -

Table 2 Type of Excavated Mounds

No	Name of Location	Number of Site
1	City Wall	KKG-16 & BTO-14
2	Citadel Partition Wall	KKG-19, 20, 25 & BTO-1 to 4, 7 & 17
3	Another Partition running North-south in the middle of the city	KKG-23
4	City Gate	KKG-13, 15 & BTO-22
5	Citadel Gate	KKG-8
6	Temporal Buildings	KKG-2, 5, 7, 17 & BTO-8, 9, 10, 11, 13, 18 & 21
7	Spiritual Buildings	KKG-3, 4, 6, 9, 10, 11, 12, 14, 18, 24 & BTO-5, 6, 7, 9, 10, 15, 16, 19, 20, 23, 24, 30, 31, 32, 33 & 34
8	Others	KKG-1, 21, 22 & BTO-25, 26, 27, 28, 29

Beikthano has a wall only on three sides. On the west, there is a tank big enough to form a natural defense. The south wall is 2.7 km long, the east wall 3.06 km long while the north wall at 2.88 km long is longer than its counterpart to the south because of its two quite different alignments. The area enclosed by the wall is 8.5 sq km. The wall is almost a square with rounded corners on the southeast, southwest and northwest. The north wall is not straight.

The north-south alignment of the east wall is 13° inclined to the west (San Shwe 2008: 1). The north-west corner was angular. Nevertheless, the wall is almost a square.

The citadel area of Beikthano is situated just at the north-west of the city. It is a compact area measuring 450 x 360 m, with the long axis running approximately north-south. The citadel is internally sub-divided by a wall running down to form an eastern and, a larger, western court. The west wall of the citadel is double walls. The citadel gateway turns to the east wall of the citadel. No traces of a gate were recovered (San Shwe 2008: 48). Three gates of the city wall were excavated, both in the north wall.

Among the structures excavated were apparent residential buildings both within and outside the palace complex, a postulated religious building containing an inner cell interpreted as a sanctum and surrounded by a circumambulatory corridor, memorial halls, a bead-making workshop and what appear to have been the living quarters of a community of Buddhist monks.

The city's socio economic basis was agriculture, enabling the consumption of rice and meat. Sophisticated irrigation systems brought water from streams through canals, to irrigate the fields. Water was stored for lengthy periods in wells and tanks that supplied the city's drinking needs as well as other uses. Numerous ornament earthen beads, earrings and necklace were found in Beikthano City. Lower quality and price stone beads and a necklace made of silver sheet were also discovered. Precious ornament gold was found there (Thein Lwin 2010: 5-16) (Aye Mi Sein 2009: 4-8).

The northern Indian culture arrived at Beikthano earlier than the southern Indian culture. This can be seen in the finding of rouletted wares in Beikthano, which were used in Taxila in 100 BC, quite similar to Beikthano's rouletted wares. In addition to this, many of the pottery designs found at Beikthano resemble similar designs made in Taxila c. 300 – 100 BC. In Beikthano, ashes of the dead were buried with the urns. Some inhumation was apparently also practiced. Beikthano urns were delineated during the manufacturing process (San Shwe 2008: 32-5). When Beikthano urns are compared to those of other cities, they exhibit the highest quality of workmanship. However, stone or brass urns were not found.

In the realm of religion, Beikthano's population practiced creeds of animism, Buddhism as well as Hinduism Paraphernalia on animism, with small brick platforms, image of women organ on slab, stupas, monasteries and rest houses with pillars are evidence of the existence of the above mentioned creeds. In addition, a bronze image of Buddha, a small bronze bell, and bronze lamps, testify to a variety of cultic activities.

What is unusual is that with the exception of a seal of *Samghasiri*, literary documents are absent from this highly developed city culture. Beikthano had contact with Amaravati in Southern India, proved by that seal that resembles similar seals found in Amaravati. Moreover coins known as Pyus' coins testify to Beikthano's trade relations with its neighboring entities. The coins, trade routes and other excavated evidence indicate the city's far flung connections. Though some scholars think that these coins were minted at Funan in second century AD, the bulk of the coins, including Beikthano's were discovered in subregions of Myanmar, which perhaps indicates that they were minted in those sub regions (San Shwe 2008: 42-4).

Most notable among other cultural affinities observed by the excavators of beikthano are the correspondences with the Pyu sites at Sriksetra and Halin as established by the presence of elaborately flanged and ridged burial urns, coins, large bricks with finger marks, and beads of clay and stones. In spite of the wealth of cultural information yielded by the site, the most significant result obtained from the excavations at Beikthano concerns the dating of the settlement. The city flourished from the 1st to the 5th century A.D.

4.   Requirement of Database GIS for Archaeological Study

The archaeological documents related to Aerial Photography, Satellite and Air-borne remote sensing. Archaeologists have been using aerial prospecting and photography since just after World War One to locate buried structures, roads, and other features of ancient landscapes. Several archaeologists who served in that air war noticed strange circles and square patterns from the air that were not visible on the ground and that were not parts of the trenches or modern landscape. After the war they returned to these locations to find that these were actually archaeological sites, ancient roads, and other features of buried ancient landscapes. Early pioneers of aerial archaeology conducted the first such surveys in Europe, Central America and the Middle East in the 1920s (Box 1999: 34-48).

Beikthano was also seen by Aerial Photo. On the image, you can see the outline of city wall, citadel area and other features. This is a good example of the difficulty of locating such structures from the air. These archaeological structures and other features in the region are marked on maps for entry into the GIS database. All archaeological data are spatially distributed within sites and within region. GIS software provides archaeologists with a powerful set of tools for management, analysis and research of cultural resources. The power of GIS lies in the ability to link objects on a map to a database, combining the graphical display of data with database query and analysis functionality. Similar objects are grouped into layers, which can be turned on or off for mapping. The map below has several different layers, with the Beikthano, layer on top, then roads, major bodies and a series of digital topographic maps as a base layer. Using GIS software, we can pan and zoom across a particular area of interest, and identify features on the various map layers. The identify results window displays the attributes for archaeological site stored in the Site File database. Once a GIS layer is built, the spatial relationships between mapped features can be analyzed for patterns readily apparent if the underlying data were viewed in tabular format. Archaeologists can analyze geographic data within a single layer or the relationship between multiple layers to examine how environmental variables like topography, soil type, or distance to water affect site location. Geographic analysis can be conducted at most any scale, from site specific to regional or state wide.

The purpose of a GIS, such as archaeological research will greatly affect the design, data content and ultimately the cost of the system. Although a GIS is most commonly implemented for a specific objective, it can also be used to assist cultural heritage managers in a wide variety of applications. The scope and coverage of a GIS can vary from site-specific to archaeological research applications depending on the needs to be addressed.

Sources of Data

The following are the list of the data that were obtained and processed.

1. **Aerial Photo**

   Aerial Photo of Beikthano site, 1:25,000 scale, 1984.

2. **Satellite Images**

   (a) LANDSAT 7 ETM data

   (b) NOAA NDVI data, 2002

3. **Maps**

   (a) Topomaps from Geography Department , Yangon University (1: 1 mile scale)

(b) Beikthano's site plan from U Aung Thaw's publication book: *Excavation at Beikthano*, 1968.

4. **Data Recorded from GPS**

Excavated Sites, Pagodas and Villages in and surrounding Beikthano, recorded from GPS surveyed By Dr. San Shwe, Archaeology Department, Yangon University.

5. **Archaeological Information**

Archaeological Information gathered from concurrent research by Archaeology Department, Ministry of Culture and Archaeology Department, Yangon University.

GIS and Remote Sensing Software

- **GIS Software**

Arc View 3.1 was used for cropping of GIS layers.

ENVI 3.5 was used for registering topographic maps.

GeoMedia Professional 4.0 was used for digitizing land cover & archaeological sites.

System of requirement

A GIS system comprises three elements:

•**Hardware**

•**Software** and

•**Data**

The hardware is the computer and the devices used to input, output and store data, and to run the software. The devices include items such as keyboard, mouse, screen and printer.

A GIS can collect, manage, display, manipulate, analyse and produce hard and soft copy of spatially referenced information. The hardware required to develop, operate and generate such information includes input devices, core components, and output devices.

Software is the program that gives instructions to the computer. GIS software can be thought of as a collection of instructions that provides the functions needed to input, store, analyse and display geographic information.

The primary software components comprising a GIS are:

• Data input and manipulation tools

• A database management system (SBMS)

• Tools providing query and visualization functionality

• Tools used to perform spatial analysis

• A graphical user interface (GUI) providing access to the tools

The third and most important element of a GIS is the **data**, either produced in-house or obtained from external sources.

The data to be included within a GIS will be defined by the needs of the users and the *spatial information products* they wish to produce. A careful analysis of requirements must be undertaken to identify the data to be included within the system.

A GIS can be used to store many different formats and types of data ranging from digital maps, numeric and textual data in tabular form to graphics such as photographs and architectural drawings, and even sound and video.

Workflow of establishing GIS database

A GIS should be thought of as a flow of data. It is not simply a database for storing data, but is a complex tool for the collection, integration, retrieval, analysis and output of data.

Registering Topographic Maps (Beikthano and its surrounding area)

Getting started

1. Make sure you have the database files you need: **topo-map images**, and to start your **ENVI** theme.
2. Start the software **Start > Programs > ENVI 3.5**. When you see the dialogue box, click on File, then click the radio button for **open image file**. New dialogue box, **Enter Data Filenames**, will open and type filename (Toposheet File Name). Then click on **Open**. Notice the small window, **Available Bands List**, will open. Click on **Load RGB**.
3. At the top of the main menu, click on **Map**. In the **Map** dialogue box, click on **Registration**, and select on **Select GCP: Image to Map**. A new dialogue box, **Image to Map Registration Box**, will open; select **Geographic Lat: / Long:** and change the x & y **coordinate, from x- 30.000000 & y-30.000000 to x-0.00005 & y-0.00005**, click on **OK**.
4. A new view dialogue box, **Ground Control Point Selection**, will open. Click on sign ↓↑. Then at the **Lat: / Long: dialogue box**, type the **Lat: / Long: coordinate**. And then click on **Add Point**.
5. After that In the **Ground Control Point Selection**, click on **Option** and then click on **Warp File**. A new dialogue box, **Input Warp Image**, will open, and select on **Select Input File**. Click on **OK**.
6. In the **Registration Parameters** dialogue box, click on **Choose**. A new dialogue box, **Output Filename**, will open and **type the file name** (Where are you saving?). Click on **Open**. In the **Registration Parameters** dialogue box, click on **OK**. Then you will see the Image Registration (Memory).

Crop Image

Getting Started

1. In the **Available Bands List** window, Click on **Display #1**. Select on **New Display** and then at the Available Bands List, click on **Load RGB**.

2. In the **Display #2** window, click on **File**. And then select on **Save Image As**, and then click on **Image File**.

3. A new view dialogue box, **Output Display to Image File**, will open, then at the **Resolution**, change the power, **from 24 bit Colour (BSQ) to 24 bit Colour (BIP)**, and then at the **Output File Type**, change the type, from **ENVI to TIFF/ GEO TIFF**, then click on **Spatial Subset**.

4. A new box, **Select Spatial Subset**, will open, click on **Map**. In the new **Spatial Subset by Map Coordinates** window, click on **sign ↓↑** at the upper part, type the **Lat: / Long: coordinates** and click on **sign ↓↑** at the lower part, type the **Lat: / Long: coordinates**. Then click on **OK**.

5. At the **Select Spatial Subset** window, click on **OK**. A new, **Output Display to   Image File**, dialogue box will open, click on Enter Out Put File Name **[Choose]** and **type the file name**, click on **OK**. In again **Output Display to Image File** dialogue box, click on **OK**. Then you will see the **Display Output to TIFF File** (Memory).

Digitizing Land Cover & Archaeological Sites

Getting Started

1. Start the software **Start> Programs> Geomeadia Professional 4.0**. You can see a dialogue box; click the radio button for **Create New GeoWorkspace**. The small dialogue box, **New**, will open and click on **New**. A new view window, **Map Window 1**, will open.
2. At the top of the **Main Menu**, select on **Warehouse**, and then select on **New Warehouse** and click on **New**. You type a **File Name** at the blank box and click on **Save**.
3. Again at the **Main Menu**, select on **Insert**, and then select on **Image**. A new dialogue bow, **Insert Image**, will open, and then click on radio button **Browse**. You type the **File Name** and click on **Open** and then click on **OK**. At the **Map Window 1**, you can see the **Topo-map** or Satellite Image or Aerial photo.
4. At the **Main Menu**, select on **Warehouse** and then select on **Feature Class Definition**, click on **New**. A new window, **New Feature Class 1**, will open and type the **Name of Feature Class 1, Geometry Type and Attributes**, what you are needed. Click on **OK**. Again at the **Feature Class Definition** window, click on **Close**.
5. Again at the **Main Menu**, select on **Legend**. Then click on **Add Feature Class**. A new small dialogue box **Add Feature Class Entry**, will open, you select the **Attributes** what you are needed and then click on **OK**.
6. After that you can do the digitizing on the **Topo-map** or Satellite Image or Aerial photo.

        Attribute data (excavated finds) are most often entered manually from keyboard directly into an attribute database. An attribute table is used to store the data associated with objects in the map. The link between the map and the attribute table is a unique reference code number. This code can be either the geographic co-ordinate of the feature or an alphanumeric code. Therefore, it is possible to search either geographically or directly search the database to retrieve information of interest.

Some analytical procedure and output maps

        Data capture of Beikthano is the process of inputting spatial data and associated attribute data into the computer. Map data can be captured from a paper map of Beikthano. Depending on the method used, the map will be converted from analogue form to either vector or raster digital format. Then you can digitize on the topo-maps and plan map of Beikthano at the computer. After digitizing, you got the Beikthano's GIS map data recorded on different layers; it is possible to visualize any desired combination of data held within the system and to generate custom-made maps. Traditional maps communicate only location and geometric information. However, because GIS uses locations for referencing attribute data, it is possible to visualize not only the location of real world objects, but also values and characteristics associated with a feature at that location.

        Attribute values relating to map features can be visualized in map form. The method will depend on the nature of the data and the type of map feature related to the attribute. A different colour is used to represent each unique value for the feature attribute being mapped. Graduated symbols are used to represent values associated with point data. Points can be plotted on the map using a symbol that is proportional in size to the value being plotted. Every point is in a study area. I order to view the digital maps and attribute data it is necessary to

output data as either softcopy (on a monitor) or hardcopy (on paper). It is possible to output the original maps and attribute tables, and the results of any queries, searches or analyses.

Data description

This section describes the various data used in the research, the source for the data, and the major processing requirements.

Table 3. Remote Sensing and Scanned Map data

Data Name	File Name	Data Definition	Remark
Aerial Photo 1984	Vishnu-tif	Georeferenced Aerial Photo 1984	
LANDSAT ETM Mosaic	LANDSAT.tif	Georeferenced LANDSAT ETM Mosaic	
NOAA NDVI Mosaic	NDVI-1.tif	Georeferenced NOAA NDVI Mosaic	
1:1mile map 84-p-8	84-p-8 tif	Georeferenced 1:1mile map 84-p-8	
1:1mile map 84-p-12	84-p-12 tif	Georeferenced 1:1mile map 84-p-12	
1:1mile map 85-M-5	85-M-5 tif	Georeferenced 1:1mile map 85-M-5	
1:1mile map 85-M-9	85-M-9 tif	Georeferenced 1:1mile map 85-M-9	

Table 4. Pictorial and GPS data

Data Name	File Name	Data Definition	GPS data
KKG-1	BTN 01 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
KKG-2	BTN 02 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-3	BTN 03tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-4	BTN 04 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-5	BTN 05if	Excavated Site at Beikthano	20.00 N, 95.37 E
KKG-6	BTN 06 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
KKG-7	BTN 07 tif	Excavated Site at Beikthano	20.01 N, 95.37 E

KKG-8	BTN 08 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-9	BTN 09 tif	Excavated Site at Beikthano	20.00 N, 95.38 E
KKG-10	BTN 10 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-11	BTN 11 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
KKG-12	BTN 12 tif	Excavated Site at Beikthano	20.02 N, 95.37 E
KKG-13	BTN 13 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
KKG-14	BTN 14 tif	Excavated Site at Beikthano	20.02 N, 95.37 E
KKG-15	BTN 15 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-16	BTN 16 tif	Excavated Site at Beikthano	20.02 N, 95.37 E
KKG-17	BTN 17 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
KKG-18	BTN 18 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
KKG-19	BTN 19 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
KKG-20	BTN 20 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
KKG-21	BTN 21 tif	Excavated Site at Beikthano	20.00 N, 95.37 E
KKG-22	BTN 22 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
KKG-23	BTN 23 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
KKG-24	BTN 24 tif	Excavated Site at Beikthano	20.00 N, 95.38 E
KKG-25	BTN 25 tif	Excavated Site at Beikthano	20.00 N, 95.38 E
BTO-1	BTN 26 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
BTO-2	BTN 27 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
BTO-3	BTN 28 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
BTO-4	BTN 29 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
BTO-5	BTN 30 tif	Excavated Site at Beikthano	20.00 N, 95.38 E
BTO-6	BTN 31 tif	Excavated Site at Beikthano	20.01 N, 95.37 E

BTO-7	BTN 32 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
BTO-8	BTN 33 tif	Excavated Site at Beikthano	20.02 N, 95.37 E
BTO-9	BTN 34 tif	Excavated Site at Beikthano	20.02 N, 95.37 E
BTO-10	BTN 35 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
BTO-11	BTN 36 tif	Excavated Site at Beikthano	20.00 N, 95.39 E
BTO-12	BTN 37 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
BTO-13	BTN 38 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
BTO-14	BTN 39 tif	Excavated Site at Beikthano	20.00 N, 95.39 E
BTO-15	BTN 40 tif	Excavated Site at Beikthano	20.00 N, 95.39 E
BTO-16	BTN 41 tif	Excavated Site at Beikthano	20.01 N, 95.37 E
BTO-17	BTN 42 tif	Excavated Site at Beikthano	20.01 N, 95.38 E
BTO-18	BTN 43 tif	Excavated Site at Beikthano	20.00 N, 95.38 E
BTO-19	BTN 44 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
BTO-20	BTN 45 tif	Excavated Site at Beikthano	20.02 N, 95.38 E
BTO-21	BTN 46 tif	Excavated Site at Beikthano	20.00 N, 95.37 E
BTO-22	BTN 47 tif	Excavated Site at Beikthano	20.02 N, 95.39 E
BTO-23	BTN 48 tif	Excavated Site at Beikthano	20.01 N, 95.39 E
BTO-24	BTN 49 tif	Excavated Site at Beikthano	20.02 N, 95.39 E
BTO-25	BTN 50 tif	Excavated Site at Beikthano	–
BTO-26	BTN 51 tif	Excavated Site at Beikthano	–
BTO-27	BTN 52 tif	Excavated Site at Beikthano	
BTO-28	BTN 53 tif	Excavated Site at Beikthano	
BTO-29	BTN 54 tif	Excavated Site at Beikthano	
BTO-30	BTN 55 tif	Excavated Site at Beikthano	

BTO-31	BTN 56 tif	Excavated Site at Beikthano	
BTO-32	BTN 57 tif	Excavated Site at Beikthano	
BTO-33	BTN 58 tif	Excavated Site at Beikthano	
BTO-34	BTN 59 tif	Excavated Site at Beikthano	

Table 5 Relational Database

Data Name	File Name	Data Definition	Remark
Beikthano's Plan	BTN.P-tif	Beikthano's Plan Database	

5.   Conclusion

A Geographic Information System is a way of managing spatial data. The use of GIS technology in archaeology continues to grow, both in the number of projects featuring a GIS component and in its recognition as a powerful management and analytical tool. GIS analytical tools have opened a number of new research opportunities as well as allowing for Old Avenue of research to become more feasible.

New technology has, in the past, been adopted by archaeologists quickly without fully understanding the nuances and limitations of that technique. As GIS technology has become more common in archaeological research it has been examined by a wider range of scholars and has been found lacking in several instances. This project briefly describes the archaeology of Beikthano, and how the information recorded in archaeological site inventories can be used in predictive modelling using GIS.

Acknowledgement

References

In English

Aung Myint, U, 1998.   Site Characteristics of Pyu and Pagan Ruins, Kyoto, an International Seminar Presented on 14 October 1998

Aung Thaw, 1968. Excavation at Beikthano, Rangoon, Ministry of Culture

Box, Paul, 1999.   GIS and Cultural Resource Management, UNESCO, Bangkok.

Hudson, Bob, 2004. The Origins of Bagan. The archaeological Landscape of Upper Burma to AD 1300, Thesis, Submitted in Fulfillment of the requirements for the degree of Doctor of Philosophy, Archaeology Dept:, University of Sydney

Moore, Elizabeth H., 2007. Early Landscapes of Myanmar, Bangkok, River Books Co.,Ltd

San Shwe, 2002. The Culture of Vishnu Old City, Thesis, Submitted in Fulfillment of the requirements for the degree of Master of Research, Archaeology Dept:, Yangon University

San Shwe, 2004. GIS Database for Archaeological Site of Beikthano, read at the Department of Geography, University of Yangon, on 21 February 2004, with Dr. Daw Mi Mi Kyi, Professor, in the Chair

San Shwe, 2006. "The Culture of Vishnu Old City" (Beikthano), Uncovering Southeast Asia's Past, Singapore, NUS Publishing, 2006, pp. 272-83

San Shwe, 2008. The Culture of Vishnu Old City, Thesis, Submitted in Fulfillment of the requirements for the degree of Doctor of Philosophy, Archaeology Dept:, Yangon University

Stargardt, Janice, 1990. The Ancient Pyu of Burmam , Volume One, London, Cambridge University press

Wheatley, Paul, 1983. Nagara and Commandery, Chicago, the University of Chicago

White, Andrew Marshall, 2002. Archeological Predictive Modeling of Site Location Through Time: An Example from the Tucson Basin, Arizona, MSc Theses, Submitted to the Faculty of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Master of Science, Department of Geography, Calgary, Alberta, 2002

Aerial Photo

Aerial Photo of Beikthano (Vishnu City) site of the year 1984

Satellite Images

(a) LANDSAT 7 ETM data, Intergraph Company

(b) NOAA NDVI data, 2002, Geography Department, Yangon University

Maps