ARCHAEOLOGICAL HERITAGE RESOURCE MAPPING: PYU ANCIENT CITIES, MYANMAR

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ABSTRACT: The Pyu ancient cities, Halin, Beikthano, and Sri Ksetra are located in the dry zone of Irrawaddy River basin. These brick-walled centres flourished for most of the First Millennium CE. These three Pyu Cities were inscribed as a serial World Heritage Site in June 2014. This process involved the preparation of documentation to map the distribution and extent of archeological heritage resources and their relationship with the environment. Archeological heritage resources are not always possible to locate only by ground survey. With limited resources and time, geographic documentation of these resources became challenging. An integrated approach was taken, using high resolution satellite imagery and topographic maps in combination with existing archaeological resources documentation and ground survey by Global Positioning Systems (GPS). The results showed that archaeological cultural heritage resources could be spatially located. The resources identified on the newly-created digital maps were classified according to archaeological properties such as palace site, city wall, hydrological system, excavated structure, unexcavated mound. The maps also classified the archaeological cultural heritage resources according to their potential outstanding universal values (OUV) of World Heritage criteria. This integrated approach was proved to be a successful tool in mapping the archaeology of the Pyu ancient cities. This method is easily replicable and adaptable to the other archaeological cultural heritage sites.

INTRODUCTION

The Pyu Ancient Cities are located along Ayeyarwady river in dry zone of central Myanmar. Halin, Beikthano, and Sri Ksetra are considered to be among the earliest examples of urbanization of Southeast Asia. Archaeological investigations started as early as 1882 (Sri Ksetra), 1904 (Halin) and 1905 (Beikthan). Halin is 18 kilometers southeast of the modern town of Shwebo. It is enclosed by a brick wall with a palace in the middle of the site. There are hot springs associated with rich salt fields to the south of the walls. Beikthano is 17 kilometers west of Taungdwingyi. A palace is enclosed by a brick wall to the south, east and north. Canals drain into the *in-gyi* or seasonal lakes to the west of the site. Sri Ksetra is seven kilometers east of the city of Pyay (Prome). Its palace site is enclosed by a 14.3 square kilometers wall which makes it probably the largest individual brick-walled archaeological site in Southeast Asia.

In response to a call from Myanmar's Department of Archaeology, National Museum and Library (part of the Ministry of Culture) for assistance in the preservation of archaeological heritage in Myanmar, in particular the Pyu Ancient Cities, a UNESCO mission was undertaken in May 2011 led by Dr. Tim Curtis, Chief of the Culture Unit of UNESCO Bangkok. Consequently, the first UNESCO project on "Capacity building for safeguarding cultural heritage in Myanmar" was undertaken from February 2012 to January 2013, funded by the Government of Italy. The immediate objectives of this project were (a) to build up a critical mass of technical capacity in key heritage conservation and management issues among the relevant government departments and other stakeholders at the national/local levels, (b) to raise conservation standards through sample restoration projects at selected sites as part of field-based training and practicum to serve as models for future work and (c) to enhance institutional capacity to identify and nominate priority heritage sites of Outstanding Universal Value.

A major component of the project was to develop a framework for Cultural Heritage Information Management using Geographical Information Systems (GIS). This included (a) development of GIS framework, (b) strengthened capacity of selected technical officials on spatial data collection and database management, and (c) map production. The World Heritage Convention calls for the identification and inventory of heritage sites as a precursor to the nomination of sites. In this regard, the mapping activity can be conducted not only to identify sites at a national level, but also to identify and inventory components within each site which should be subject to protection. GIS technology allows for a comprehensive mapping of cultural objects, along with environmental features, socio-cultural features,

socio-economic data and infrastructure. Therefore the maps from outputs were expected to be able to identify the cultural heritage and environmental features which have significance and thus constitute the physical attributes of the World Heritage properties. In this paper, the development of spatial data or GIS data implemented during this 12 months project using integrated data sources shall be discussed. As GIS is a powerful tool able to handle vast amounts of complex data, it was selected to be used for archaeological database construction and management, and as an analytical tool for archaeological site management and conservation.

STUDY AREA

The three Pyu cities of Halin, Beikthano, and Sri Ksetra developed and flourished during the First Millennium of the Common Era in the Dry Zone of the middle Ayeyarwady (Irrawaddy) River basin (Figure 1). They were the central places of a widespread cultural system. This system is identified by Buddhist sculptures; other more syncretic sculptures such as representations of Vishnu; coins bearing Indic symbols (though sadly for historians, no dates); inscriptions, mainly in the largely undeciphered Pyu language but some in Sanskrit or early Pali; sun-dried bricks marked with fingerstrokes, letters or numbers; intaglios that are sometimes reminiscent of Indian, Roman or Sasanian models; religious buildings, and cremation burial sites. Art historians have noted similarities with the sculpture of Thailand's Dvaravati culture. A distinctive feature is the manufacture of gold beads, rings or bracelets, which are found even today in and between the Pyu cities, frequently coming to public attention when a finder donates them to a museum. Pyu hydraulic engineering is noteworthy: at Sri Ksetra, water still flows in the rainy season along parts of the First Millennium CE drainage system.

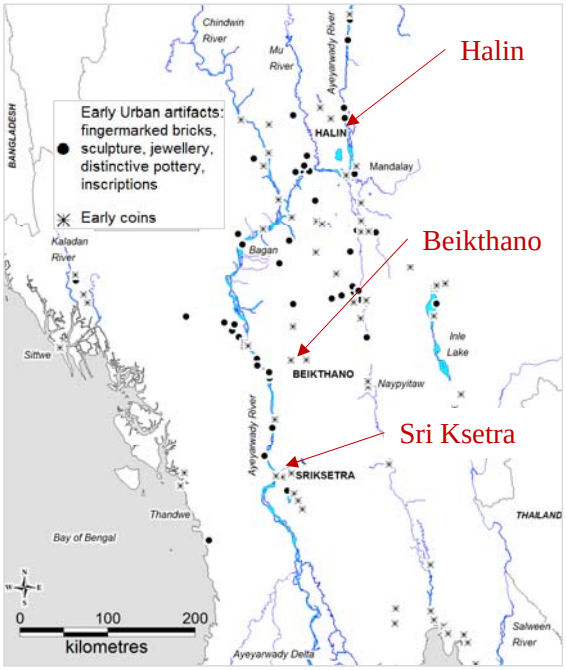

Figure 1. Map of Myanmar showing the location of three Pyu Cities.

MATERIALS AND METHODS

To map the heritage resources of the Pyu Cities for the immediate needs of the Department of Archaeology (DoA) for World Heritage nomination, a map scale as large as 1:10,000 was targeted. This was challenging considering the project timeframe. Therefore, the project made use of existing data on scanned topographic maps, Landsat imagery, IKONOS imagery, Google maps, GIS based layers and archaeological data layers in combination with field survey data using Global Positioning System (GPS). High resolution satellite imagery became a major data source for the identification of archaeological remains and their associated environment. The computer program ArcGIS was used for data input and GIS processing. A standardized projection system, Universal Transverse Mercator zone 46 Northern Hemisphere and World Geodetic Datum 1984 (UTM46WGS84), was applied.

Compilation of Existing GIS Datasets

Data collection has been carried out based on rapid assessment of data availability both in Myanmar and from outside Myanmar. The country level data was collected from the UNESCO Bangkok archive, Digital Chart of the World, USGS and MIMU (Myanmar Information Management Unit). The main datasets at country level are:

- Scanned topographic map 1:50,000 scale 2010 edition
- IKONOS satellite imagery of 2004
- DEM (digital elevation data which provides a 3D representation of a terrain's surface) at 30 meters resolution.
- Administrative boundaries.
- Transportation network
- Hydrological network
- Location of archaeological sites

At site level the existing data was mainly collected by individual researchers and partly by DoA. The biggest archaeological heritage resources datasets over three Pyu Cities were collected by Dr. Bob Hudson. The archaeological heritage resources data layers are:

- Archaeological remains: city wall, city gate, palace citadel, Pyu Taik (burial platform), religious building, monument, iron furnace, etc.
- Geospatial location of ancient manufacturing of products such as bricks, gold, salt, beads etc.
- Geospatial location of ancient hydraulic systems.

These data were developed from multiple sources with different details in terms of scale, accuracy, classification system, purpose of use and projection systems Transformation of data such as re-projection and conversion from MapInfo to shapefile for integration into the DoA GIS system was performed before further GIS analysis. Land use data layers and other base layers on current infrastructure and hydrology were developed from scanned topographic maps and IKONOS satellite imagery. The internet-based Google Maps was also used for back-up information.

Field Data Collection by GPS

Data gaps were identified based on the available data against the requirements of data for World Heritage nomination, as well as for site management and conservation in the future. The GPS survey activities were carried out by the GIS team of the DoA in mid-2012 to clarify:

- Ground Control Points (GCP) for image rectification,
- Partial archaeological remains which could not be identified easily from satellite imagery,
- The possible World Heritage nomination areas and their buffer zones,
- Settlement boundaries,
- Current infrastructure networks such as power cable and roads, and.
- World Heritage demarcation points.

Development of GIS Datasets of Pyu Ancient Cities

The spatial data on archaeology was based on existing data with some adjustment and clarification of geographical locations. Attribute data had to be modified and re-classified according to the immediate needs for World Heritage nomination as well as the potential applications for site management and conservation in the future. The process of GIS database development included:

Contemporary base layers

The base layers for viewing the potential World Heritage sites within the context of their current use were infrastructure, hydrological network, and land use. Since the existing data on base layers are developed at a national and regional level, it was not sufficient to be used for a World Heritage site. Thus additional infrastructure information was digitized from 1:50,000 topographic maps.

Archaeological location layers

The archaeological location layers were generated from a mixture of existing data layers and new data collected in the field using GPS. These layers include:

- City wall, fortification, and palace citadel, recorded as lines.
- Ancient monument, religious building, city gate, excavated site, un-excavated mound, recorded as points.
- Palace site, excavated and unexcavated site, hydraulic system, geo-spatial location of ancient habitation areas, recorded as polygons

Quantifying according to World Heritage criteria

Upon completion of the spatial data development, the development of attribute data based on World Heritage criteria was undertaken. This was done by classifying the archaeological property to be nominated in relation to identified criteria of Pyu Ancient Cities, as outlined in the Nomination Dossier:

- (Criterion ii): Over a prolonged period of interaction between indigenous societies with Indic cultures to the west starting after the 2nd century BCE, Buddhism achieved its first permanent foothold in Southeast Asia among the Pyu cities, where it was embraced by all classes of society. The development of Pyu Buddhist urban culture had widespread and enduring impact, following the onward transmission

of Buddhist teaching and monastic practice into other parts of mainland Southeast Asia.

- (Criterion iii): The Pyu Ancient Cities marked the emergence of the first historically-documented Buddhist urban civilization in Southeast Asia. The establishment of literate Buddhist monastic communities arose in tandem with the re-organization of agricultural production, the specialized production of manufactured goods, the construction of religious monuments in brick, and the development of unique mortuary practices.
- (Criterion iv): Technological innovations in resource management, hydraulic engineering, agriculture and manufacturing of brick and iron at the Pyu Ancient Cities created the preconditions leading to significant advances in city planning and building construction, resulting in the creation of urban prototypes which later proved critically influential for later city formation in Southeast Asia.

Data layers for the World Heritage sites

These layers consist of location of settlement area, World Heritage site zoning and World Heritage site management plan zoning. The location of settlement areas to be used for the proposed management plan of the World Heritage sites was digitized from the existing 1:50,000 topographic maps and later confirmed by field survey by GPS. The World Heritage site management plan zoning followed the updated demarcation of the Ancient Site Zone under the Law on the Protection and Preservation of Cultural Heritage Regions 1998 (Amended 2009) of Myanmar. The World Heritage site zones presented each proposed World Heritage property area surrounded by a buffer zone. Both zoning areas were based on the World Heritage site management plan. These zonings were carried out in three steps, (a) locating the World Heritage site management plan zoning on the satellite image, (b) tracing the World Heritage property area and buffer zones based on the physical features, and (c) confirming the zoning areas on the ground.

RESULTS AND DISCUSSION

As mentioned earlier, development of GIS datasets on base layers, archaeological location and World Heritage layers of the Pyu Ancient Cities was mainly done through the compilation of existing datasets. Existing data is not always compatible or at the right scale, the right format, or acceptable accuracy. Compilation of existing GIS datasets was carried out regardless of map scale, map accuracy, or data format. As a result, it took a major effort for the GIS team in the DoA to be able to integrate the existing data into the DoA-GIS system. The major problem the DoA team faced when developing GIS based layers for World Heritage nomination of the Pyu cities was the map scale. The map scale of existing data layers was often only as large as 1:50,000 which is insufficient for identification and inclusion of small heritage objects (Figure 2). The GIS team of the DoA worked to improve map quality. The base data layers such as river/stream, road, were added by digitizing from 1:50,000 topographic maps in combination with GPS survey. The improvement of the accuracy of contemporary land use maps using satellite imagery remains an onging project. Position accuracy and redundancy of data/information created another problem when combining data from various sources.

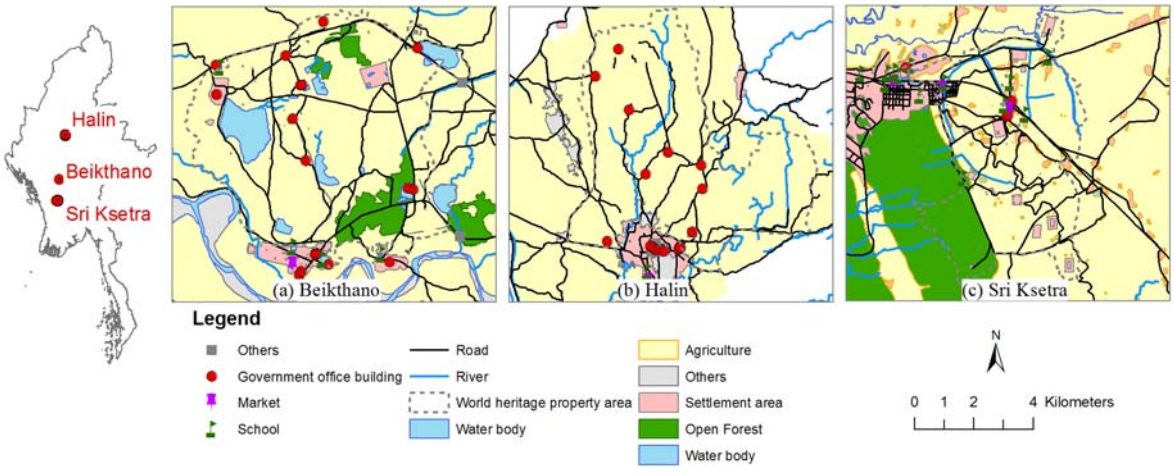

Figure 2 Existing base layers of the Pyu Ancient Cities.

Field Data Collection by GPS became crucial to fill in the data gap, update map information and improve the spatial accuracy of data. In case of Sri Ksetra, infrastructure elements such as gas lines, electric power lines and some human activities were not fully identifiable on satellite imagery. Figure 3 shows examples of GPS survey results.

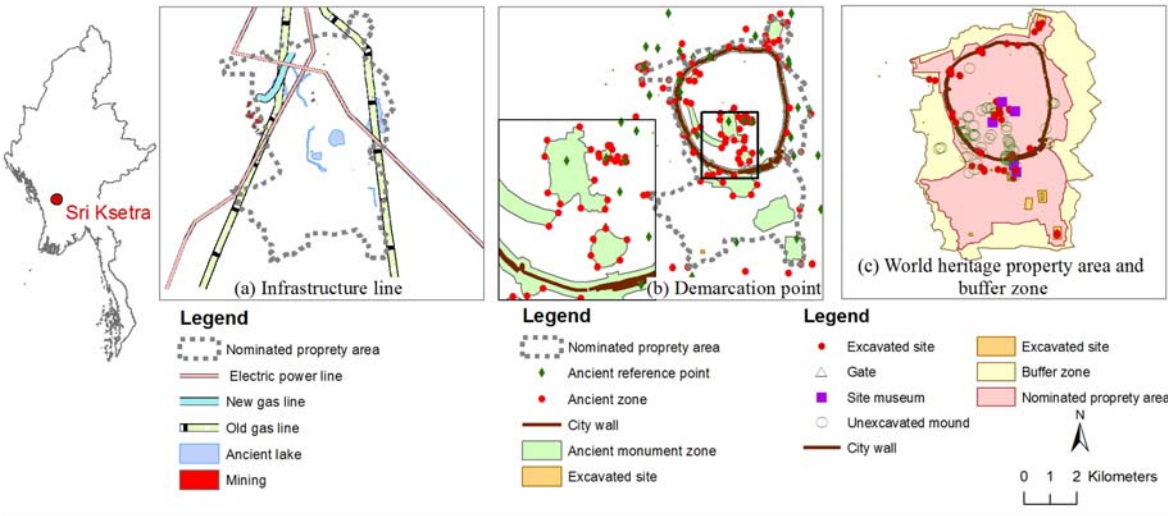

Figure 3. Data layer generated from the GPS survey of Sri Ksetra

As time from the project start to the time of submission of the World Heritage nomination dossier was not sufficient for the project team of UNESCO and the GIS team of the DoA to carry out all necessary steps toward the development of GIS data layers on archaeology for World Heritage, the development of GIS layers has emphasized data consolidation and transformation. Accuracy and quality assurance have suffered a little. However, as the saying goes, at least we know what we don't know. Within the limited timeframe and available GIS data sources, attribute data on World Heritage has been successfully added and plotted out on the maps. Figure 4 demonstrates the distribution of archaeological heritage properties which were nominated to be inscribed in the World Heritage list of three Pyu Ancient Cities as a result of attribute data processing.

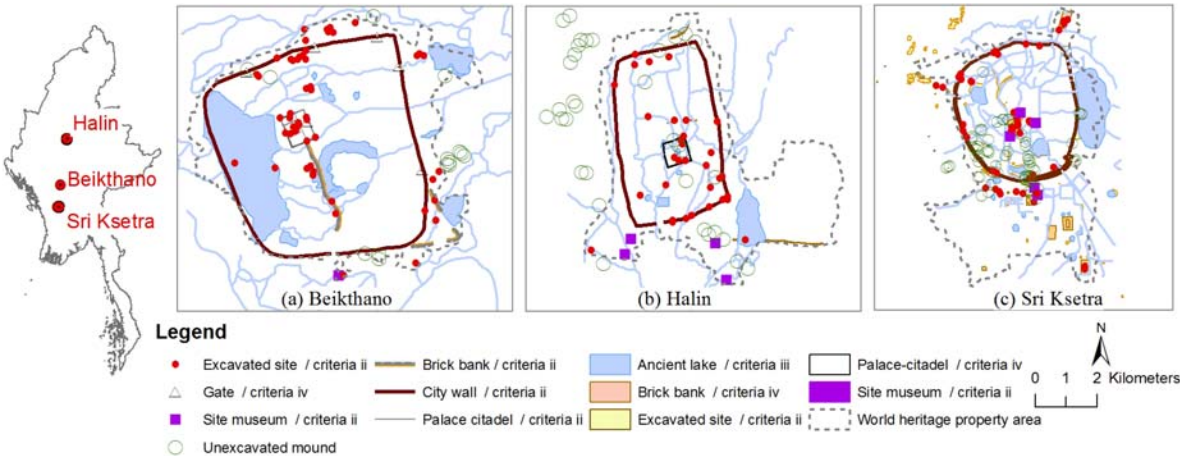

Figure 4. Archaeological properties by World Heritage criteria

CONCLUSIONS

This paper describes the mapping of the archaeological resources of the first World Heritage site of Myanmar. An integrated approach of mapping was applied by using high resolution satellite imagery and topographic maps in combination with recent GPS data. The implementation of this mapping exercise revealed that within the limited timeframe, archaeological heritage resources were successfully located and mapped, and satisfied the World Heritage nomination purpose. Both positional and attribute data was as accurate as available data sources within the provided time for data processing. However, for site management and conservation in the future, better data accuracy needs to be obtained. To improve mapping accuracy, a longer time for data processing is needed. More varied approaches on data processing should be taken into account. For archaeological heritage resource layers on geo-spatial locations and ancient hydraulic systems, further analysis of detailed topographic data or DEM could be integrated with interpretations of aerial photographs. For a large-scale land use map, updated high resolution aerial photos should be acquired.

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