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Figure 38 reproduced with permission of Vince Gaffney from Gaffney V. and Stancic Z. GIS approaches to regional analysis: a case study of the Island of Hvar, University of Ljubljana, 1991, figure 42, p. 70.
If sustainable development is to be achieved in the rapidly changing world of the 21st century, we must be vigilant to ensure that the economic gains realized are not eroded by a development that is without human or cultural value. The antidote to faceless globalization lies in the valorization of the particular characteristics of each place in the world system, and the founding of the economic and social development of every community in that community’s unique cultural heritage. The way to ensure that development is not synonymous with dehumanization is to guarantee that traditions, histories, cultures and habitats are safeguarded in all their rich diversity.

Cultural heritage is the most universally valued and most evenly distributed resource in the world. However, it is also both fragile and finite. To the task of preserving the sites of our heritage we must bring the best and most appropriate tools available. The United Nations Educational, Scientific and Cultural Organization (UNESCO) encourages the use of computer software to aid cultural resource management. UNESCO also facilitates specialized training for heritage site managers in the use of computerized tools.

Although the safeguarding of heritage has always been a central concern of UNESCO, the focus on the use of modern electronic and computer-based information technologies to support this work is a relatively recent initiative. A decisive step in the use of computer-aided tools for archaeological site management was taken in 1992 when UNESCO was faced with the task of assisting the new Cambodian government to preserve the World Heritage site of Angkor which had suffered much during 20 years of civil unrest. At Angkor, UNESCO pioneered the use of computer-assisted information management tools to bring together fragmentary data from many sources in order to create a data bank to guide restoration work on the monuments, and to aid in the creation of an economic and human resource development plan for the devastated surrounding area.

The Angkor Zoning and Environment Management Plan (or ‘ZEMP’ as it became known), used computer-assisted geographical information systems (GIS) to integrate data from the fields of archaeology, geology, hydrology, climatology, environmental science and demography together with plans being prepared for the development of agriculture, irrigation, road construction and, of course, tourism. The purpose of compiling such an integrated database was to encourage planners and developers from all departments to work to the same plan thereby ensuring that the archaeological remains of Angkor would not be endangered by ill-conceived or uncoordinated actions.

UNESCO consciously chose to test the usefulness of computer-aided GIS in the difficult situation at Angkor where map data was non-existent, electricity rare and where no local manager had even heard of GIS, to say nothing of being trained in its use. If GIS could also prove to be useful at Angkor, then it had the potential to be developed by UNESCO into a powerful tool to aid site managers everywhere to safeguard the world’s heritage.

GIS has indeed demonstrated its usefulness at Angkor and subsequently at other UNESCO pilot sites at Hue, Viet Nam and Vat Phou, Lao PDR as well as at sites in Europe, Australia and North America where others have also been developing GIS related applications for natural and cultural site management. GIS is a proven tool which should be made available to all site managers everywhere in the world.

The purpose of this manual is to provide an accessible introduction to GIS and the uses of GIS as a tool for culture resource management for site managers and culture policy makers at both the local and national levels. The manual is intended not only for heritage experts but also for all planners and managers who need to integrate heritage protection into regional development projects. In addition to an introduction to GIS method and theory, the manual shows step-by-step how to implement a GIS in field situations and how to make use of GIS for site management and monitoring. The
manual includes case studies from around the world to give practical examples illustrating the theoretical discussion. The appendices to the manual include a glossary of GIS terms, a guide to available hard and software, and useful addresses for further technical assistance. Throughout the manual, the emphasis is on inexpensive, easy-to-use, in-field applications of GIS for practical site management.

The publication of this manual has been made possible thanks to a generous donation by the Government of the Republic of Korea to the UNESCO World Heritage Centre for this purpose. This contribution by the Korean Government will help to ensure that state-of-the-art GIS management tools are not a luxury only the wealthiest societies can afford but are available to all countries to safeguard every heritage site.

Many others have also contributed generously of their time and given their support to ensure that this manual meets the highest professional standards. The principal author, Paul Box, has worked tirelessly with UNESCO over the past six years to develop appropriate GIS applications at the pilot sites of Angkor, Hue and Vat Phou. Likewise, the encouragement and support of the UNESCO World Heritage Centre and the UNESCO National Commissions of Cambodia, Viet Nam and Lao PDR have been invaluable in developing UNESCO GIS strategy at these pilot sites.

It is our hope that the readers of this manual will find it useful in developing programmes of integrated cultural resource management at heritage sites throughout the world. This manual is also intended to be used as a starting point for training and research in GIS applications by the network of UNESCO-affiliated universities and institutions offering professional training in culture resource management. We hope that by promoting the use of GIS as a practical on-site management tool accessible to everyone, the world’s rich and diverse cultural heritage will be better preserved and that the cultural resources of communities everywhere will be better used to form a basis for sustainable human development.

Richard A. Engelhardt
UNESCO Regional Advisor for Culture in Asia and the Pacific
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Paul Box
UNESCO GIS Consultant
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THE USE OF GIS FOR DEVELOPING A HERITAGE PROTECTION ZONING STRATEGY FOR VAT PHOU CHAMPASAK HERITAGE AND CULTURAL LANDSCAPE PROTECTION ZONE, LAO PDR.

Author: Paul Box
UNESCO
Site name: Vat Phou Champasak Heritage and Cultural Landscape Protection Zone
Country: Lao PDR

Summary

The site of Vat Phou in southern Lao PDR is a unique Khmer period cultural landscape. The site includes standing monuments, vestiges of ancient cities, an ancient hydrological system and rich archaeological remains.

In 1996, UNESCO with support of the Italian and Japanese governments and in collaboration with the Lao PDR Ministry of Information and Culture formulated a project to develop a management plan for the Vat Phou site. A GIS was used to collate and archive archaeological, geological, demographic, land use and hydrological data collected by a multi-disciplinary team. The GIS was then used to assist in the analysis of these data to develop a heritage protection zoning strategy for the site.

1 Introduction

1.1 The Vat Phou site

The Vat Phou monument complex is located close to the Mekong River in the southeast of Lao PDR, approximately 500 km from Vientiane. The site includes the main temple complex of Vat Phou, several standing monuments and, on both sides of the Mekong River, an archaeologically rich cultural landscape dating from the 5th century. Archaeological research has identified many other sites including an ancient walled city on the west bank of the Mekong River, another walled city on the hillslope, numerous other settlement sites, as well as numerous mines, industrial workshops and traces of former planned watercourses and roads.

The ancient walled city, dating from the 3rd to the 7th century and continuing into the 13th century, is one of the earliest known urban settlements in mainland Southeast Asia. It is the only city of its type to have been extensively investigated. As such, the site provides unique and valuable evidence for the origins of urbanism (see Figure 6.1).

The Vat Phou temple complex is a Hindu-Buddhist sanctuary of the Khmer Empire period, which spanned from the 9th to the 13th century (see Figure 6.4). The temple complex covers four square kilometres and includes the following elements: the main temple on the upper terrace; six shrines on the middle terrace; two so-called palaces and a Nandin hall on the lower terrace; and two large reservoirs (barays) situated on a one kilometre causeway leading to the temple complex. There are several other standing monuments scattered throughout the area surrounding the temple complex (see Figure 6.2).

The Vat Phou temple complex was organized around symbolic landscape features, including Phou Kao Mountain, which has a natural rock lingam at its summit, and the Mekong River.

The significance of the landscape elements in the original planning of the temple complex is still evident. To preserve this cultural landscape, in addition to the preservation of the man-made features, issues of environmental management also must be addressed at Vat Phou.
1.2 Project background

In response to a request by the Laotian government for assistance in preserving Vat Phou, several UNESCO missions were undertaken in 1985 and 1986. Draft legislation for the preservation of cultural heritage was prepared and a UNESCO project was undertaken from 1987 to 1990. As a result of this project, provincial heritage protection legislation was implemented.

Since 1990, a joint Italian and French team, in collaboration with the Department of Archaeology of the Laotian Ministry of Information and Culture, has been conducting archaeological research at the site. This research has focused on the archaeology of the site, as the standing monuments were already well documented.

UNESCO and the Lao PDR Ministry of Information and Culture formulated a preservation project for Vat Phou in 1996. The funding was provided by the governments of Italy and Japan.

2 Project objectives

The objectives of the Lao PDR - UNESCO Vat Phou project are to:

- Conduct continued scientific investigations of the Vat Phou site to develop a management plan that will guide the preservation, presentation and development of the site. A management plan for the Vat Phou site is also a part of the documentation required for the nomination of the site for inscription on the UNESCO World Heritage List.
- Establish a national Laotian staff with the institutional, technical and professional capabilities necessary for the preservation and development of the Vat Phou site.

3 GIS methodology

In this project, a GIS was used for the following activities:

- Collecting, archiving and analysing archaeological and other data generated through on-going investigation and documentation of the site
- Developing a management plan for the site
- Developing conservation plans for the site
- Defining mechanisms for control of development
- Monitoring and evaluating management and conservation policies

3.1 Software selection

A GIS solution was sought that would be appropriate to the technical and institutional capabilities of the site management team. The criteria for selecting GIS software for the project were:

- An easy to use, ‘off-the-shelf’ solution
- The ability to read industry-standard data formats
- The ability to utilize both vector and raster data structures
- Good after-sales service and support

The software chosen was ArcView Version 3, developed by ESRI. ArcView provides all the commonly required functionality, but has limited analytical capabilities.

Although many ‘off-the-shelf’ GIS packages offer similar functionality, ArcView was selected for the following reasons:

- Many government agencies in Lao PDR that are potential data suppliers already use ESRI GIS products and could provide compatible data
- An authorized ESRI distributor in Vientiane provides after-sales support and training
3.2 The GIS team

To staff the GIS team, three Laotians, an archaeologist, a museum specialist and a conservator, were selected for GIS training. They received the following training:

- An introductory course covering the basics of hardware, the use of Windows 95, databases and word processing
- An introduction to cartography and the concepts of GIS
- Instruction in the use of ArcView
- Instruction in topographic survey and GPS basics

One problem was that no GIS team member was assigned as a full-time GIS operator. The team members' other professional duties meant a lack of continuity in data processing and management. If an operator does not regularly use GIS, operating skills can be lost and continual re-training is required. The lack of a full-time GIS operator is an issue that must be addressed to sustain the Vat Phou GIS implementation.

3.3 The data

3.3.1 Archaeological data

Spatial data

From 1990 to 1996, archaeological data on the Vat Phou site were collected from a variety of sources. An initial reconnaissance survey of the area was undertaken in 1991 to identify areas of archaeological potential. This survey used aerial photography at 1:40,000 scale. The sites of archaeological potential were interpreted from the aerial photography and digitized using AutoCAD.

A series of field surveys were undertaken to further investigate each of the identified potential archaeological sites. These field surveys documented the following types of archaeological features:

- Standing monumental structures including temples, rock shelters, and carved rocks
- Three types of mounds:
  - Mounds with superficial ruins related to religious buildings
  - Mounds with scattered bricks
  - Mounds without surface material
- Ancient hydrological features:
  - Canals
  - Dykes
  - Barays (traditional rectangular water storage tanks or ponds)
- City walls
- Surface finds:
  - Worked sandstone
  - Bricks and laterite blocks
  - Scatters of potsherds

The location of many sites and objects of interest were recorded by traverse survey, the results of which were digitized into AutoCAD.

In late 1997, a multi-disciplinary team of several archaeologists and geologists, an art historian, a geo-physicist and a GIS technician were fielded. The team was equipped with magnetometers for magnetic prospecting, GPS (an Architech base station and a mobile GPS unit with an attached data-logger), and theodolites for topographic survey.

Archaeological sites and features identified during the first phase of the project were re-visited with the GPS to accurately record locations and to collect attribute data. The boundaries of mounds with discernable shapes were recorded. Eroded mounds or
mounds lacking a clearly definable boundary were recorded as single points. The resultant archaeological data were then downloaded from the data-logger, processed and imported to AutoCAD as DXF files.

Verification of the existence and assessment of the condition of buried remains was undertaken using a magnetometer, a non-invasive technique (Curcarzi and Zolese, 1997). A magnetometer measures anomalies between the magnetic field of the earth’s surface and buried objects. Using the results of a magnetometer survey, it may be possible to generate a geomagnetic model that indicates the shape, dimensions and, in some cases, the condition of buried objects.

The magnetometer survey focused on investigating mounds believed to contain religious structures. As time was limited, the archaeological team prioritized features to be investigated using the magnetometer. The evaluation was based on surface evidence and the level of site disturbance. A GPS was used to record the location and a theodolite was used to conduct a topographic survey of all the mounds investigated with a magnetometer. These survey data were then digitized to produce three-dimensional topographic models of each mound.

The results of the magnetometer investigations were visualized using a surface creation software package, Winsurfer. Of the 34 mounds investigated using a magnetometer, evidence of sub-surface archaeological remains were found at 21.

Site plans of important standing structures were produced using a combination of GPS and theodolite survey. These data were then digitized into AutoCAD.

All archaeological data were imported as DXF files into ArcView. Archaeological features were subdivided, converted to ArcView shapefiles and recorded in the following GIS layers:

- Standing monuments
- City walls
- Mounds
- Canals
- Dykes
- Barays
- Scattered finds

**Attribute data**

Attribute data describing the archaeological features surveyed were collected using a combination of GPS data-logger and field survey sheets. The data recorded included description, origin, material, dimensions, and classification of features.

In addition, the team assessed the archaeological and tourist value of each feature. For both evaluations, a rating from zero to five (none and high), respectively was assigned to each feature. The assessment of archaeological value was made by the team's archaeologists based on the results of field survey, magnetometer survey and professional experience. All standing monuments and city walls were automatically assigned an archaeological rating of five. Other features were each assessed and assigned an archaeological score.

### 3.3.2 Topographic data

Maps of the whole study area were generated by manually digitizing 1:100,000 scale topographic map sheets. The following layers of base map data were produced:

- Roads
- Tracks and paths
- Permanent rivers and streams
- Seasonal rivers and streams
- 100 metre elevation contours
Village locations
Administrative boundaries

For the areas of in-depth archaeological investigation, primarily the ancient city and the area surrounding the Vat Phou temple complex, a larger scale base map was required. This base map was generated using a combination of interpretation of aerial photography at 1:40,000 and GPS ground survey.

3.3.3 Demographic data

A census had previously been undertaken by the Champasak Provincial Statistical Bureau. A subset of this data was entered into a demographic database. For each village data included total population, population distribution by age and gender, occupation, income level and literacy rate. Village locations were digitized from 1:100,000-scale topographic maps as points in ArcView. The Excel database was then imported to ArcView and each village record was linked to the point representing the village location by a common code.

On the larger scale map of the ancient city and the area surrounding the Vat Phou temple complex, villages were recorded as polygons. The boundary of each village was surveyed using GPS. The relevant village records from the village database were then attached to the polygons representing the location of the village by a common code.

3.3.4 Environmental data

Generalized land cover maps of the study area were generated by manual interpretation from 1:40,000-scale aerial photographs. For these land cover maps, individual land use polygons of less than 0.5 hectare were incorporated into the nearest neighbouring land use class. The following land use classification scheme was used for the land cover map:

- Upland secondary forest
- Mixed sparse secondary forest and shrub-land
- Mixed shrub-land and dispersed rice paddy
- Rice paddy
- Alluvial sand

A larger scale land cover map for the ancient city was generated from 1:40,000-scale aerial photography. The following land cover classification scheme was used for this map:

- Sparse secondary forest
- Mixed forest and shrub-land
- Rice paddy
- No vegetation cover

3.3.5 Unexploded ordnance (UXO) data

Lao PDR suffers from heavy unexploded ordnance (UXO) contamination from the prolonged period of war until 1975. To evaluate the UXO problem and prioritize areas for clearance, the Lao UXO project established a GIS. The GIS records the number and type of UXO sighted within the administrative boundary of each village. Although UXO contamination in the study area is low, it was decided that these data should also be included within the Vat Phou GIS.

4 System use

GIS analysis of the Vat Phou site was carried out using ArcView Version 3.0 with Spatial Analyst 1.0a extension. The cultural resource inventory formed the basis of the analysis. In addition, since the site contains important symbolic natural features, an emphasis was also placed on conserving the environmental resources of the cultural landscape.
4.1 Elaboration of a site management plan

The intent of the protection planning process was to develop a zoning strategy that integrated cultural and natural heritage protection with the needs of socio-economic development. A strong inter-dependency exists between the local community and the natural resources upon which it relies. A programme entitled Heritage Awareness Through Community Outreach was implemented to empower the local community to participate in the heritage management process. The objective of this on-going programme is to improve the understanding of the region’s heritage and to establish its protection requirements.

The standing monuments, most of which are still actively used for worship, are respected by the local population and are not in great danger from human activity. The most difficult elements of the site to protect are the sub-surface archaeological features. Many of these are located in agricultural land, primarily rice paddy, and are in close proximity to villages. Any plan for the protection of sub-surface features has to accommodate the land use needs of the local community.

4.2 Protection zones

Zoning boundaries needed to be established for the management plan. It was decided that to clarify the zones, the boundaries should, wherever possible, follow physical features such as cart tracks or streams. To make a theoretical plan into a workable management tool, both managers and local populations must be able to easily identify zone boundaries on the ground.

The first step was to identify the values of the site to be preserved. At Vat Phou, the values of the site are in the standing historic structures, the buried archaeological remains and the cultural landscape. In addition, the Mekong River setting and selected contemporary villages containing traditional housing types were identified as being of significance to the overall character of the site.

After having identified the values of the site to be preserved, the following four inter-related zones of protection were defined:

Zone 1: Champasak Heritage and Cultural Landscape Protection Zone
Zone 2: Sacred Environment Conservation Zone
Zone 3: Archaeological Research Zone
Zone 4: Monument Management Zone

Elements of the cultural landscape have different protection needs. The plan establishes policies for

- Protection of the cultural landscape as a whole
- Protection of sub-surface archaeology
- Protection of settlement character and traditional buildings
- Protection of the natural environment
- Protection and enhancement of the landscape setting
- Control of new development
- Regulation of traditional land use

(UNESCO, 1998)

The following sections describe the use of the GIS in developing the protection zoning strategy.

4.2.1 Champasak Heritage and Cultural Landscape Protection Zone

The Champasak Heritage and Cultural Landscape Protection Zone protects the setting of Vat Phou to preserve the symbolic landscape. In order to define this zone, a series of thematic maps were produced. These maps included

- Land cover and settlements
- Standing monuments and archaeology
Hydrology and topography

Using the GIS, the project team identified the location of cultural and natural resources to be protected and proposed a series of alternative protection zone boundaries for discussion. A decision was made to define a boundary for this zone that is demarcated in the west by a river, in the south by a road and in the east by a border 100 metres inland from the Mekong River. The boundary is shown in Figure 6.3.

The regulations for this zone include:

- Consent from the site management agency is required for any works that may affect the character of the zone. Works include new building construction, irrigation systems, roads, electrification and any excavations deeper than 0.5 metre
- All archaeological finds must be reported to the site management agency
- Maximum building height is 12 metres

### 4.2.2 Sacred Environment Protection Zone

The Sacred Environment Protection Zone was defined to protect the most important components of cultural landscape such as the sacred mountain of Phou Kao and the natural rock lingam (lingapravarta) at its summit.

In this zone, it was important to identify ecological units of high natural value that were relatively unaffected by human activity. This zone is a dual-purpose zone established to protect both the forests of the mountain as a natural resource and the forest, mountain and lingam as a cultural landscape element. To develop the zoning strategy for this zone, land cover, elevation, cultural resources and settlements maps were generated.

An initial assessment of the topographic base map indicated that no appropriate physical boundary could be used to define the zone. Therefore, it was decided that a line following the 200-m elevation contour would be the boundary. This elevation is the transition from the open forest and shrub-land on the gently sloping foot of the escarpment to the dense upland forest cover on the steep mountainous slopes. Symbolic and physical reinforcement of the transition from plain to mountain at this elevation is marked by a high concentration of standing monuments including the main shrine of Vat Phou on the east of the Phou Kao massif. The boundary is shown in Figure 6.3.

Important regulations applying to Zone 2 include:

- Prohibition on all tree-felling, excluding the collection of branches and small bushes
- No construction
- No cultivation

### 4.2.3 Archaeological Research Zone

A research zone was established to protect known archaeological sites and other areas with high archaeological potential. This protection zone must accommodate other existing land use requirements.

The first step of the analysis was to produce a series of thematic maps indicating the location and archaeological value (from zero low to five high) of all archaeological features.

This archaeological value map was used to define archaeological protection zones. The protection areas were defined as the geographical extent of each archaeological feature plus a ‘buffer’. Features vary in degree of archaeological importance and it was decided that the extent of the buffer would vary accordingly. The following buffer dimensions were originally defined:

- Sub-surface features: value 1 - 3: 30-m buffer
- Sub-surface features: value 4 - 5: 50-m buffer
- Ancient barays: value 1 - 3: 30-m buffer

CASE STUDY
Ancient baray: value 4 - 5: 50-m buffer
Ancient road: 50-m buffer
City walls: 30-m buffer
Ancient channels: 5-m buffer
Ancient dykes: 5-m buffer

The resultant archaeological protection zone map showed that in all areas of high archaeological site density, the proposed protection zone boundaries of individual features overlapped. Although the majority of the ancient city would be designated as an archaeological protection zone, the resultant overlapping protected areas created islands of unprotected land. In addition, outside the ancient city, the resultant protection zones defined a large number of discrete zones covering a large geographical area. This protection zoning strategy was unacceptable for the following reasons:

- Protecting all of the archaeological sites would require the prohibition of most land use including agriculture. It would be difficult to justify taking such a large area of cultivatable land out of agricultural use.
- Managing a large number of discrete protection zones with boundaries that are difficult to identify would be almost impossible.

The initial zoning strategy demonstrated that a ‘damage limitation’ approach to the protection of the archaeological sites was required. The aim of this approach would be to protect the most important sites from all human activity including agriculture and allow the continuation of other land uses including agriculture on and around less important sites.

Therefore, archaeological sites were re-classified into four groups

- No value: 0
- Low value: 1 and 2
- Medium value: 3 and 4
- High value: 5

The re-classified features were then plotted on a thematic map.

Most of the archaeological sites scored as value 5 had been investigated using a magnetometer. In some cases, the geomagnetic survey had verified the existence of buried archaeological remains in a good state of preservation, essentially buried monuments of high value. After the re-classification it was decided that all high value archaeological features should be designated as Zone 4 protection zones. It was also decided that features of low archaeological value would not be individually protected, but would receive a general level of protection as part of the cultural landscape of the site.

New buffer maps were produced using the following dimensions:

- All features low value 1 - 2: no buffer
- Sub-surface features: medium value 3 - 4: 30-m buffer
- Sub-surface features: high value 5: 50-m buffer
- Ancient barays: medium value 3 - 4: 30-m buffer
- Ancient barays: high value 5: 50-m buffer
- Ancient road: 50-m buffer
- City walls: 30-m buffer
- Ancient channels: 5-m buffer
- Ancient dykes: 5-m buffer

The resultant map again showed a series of overlapping and discrete protected areas. The new maps indicated that the majority of archaeological sites were concentrated in three main areas: the ancient city, a possible second urban centre to the south of the Vat Phou temple site and the area surrounding Oubmong Temple on the east bank of the Mekong River. It was decided that individual features within the sites would be combined and protected as composite zones. These three areas were then defined
as Zone 3: Archaeological Research Zones (see Figure 6.3).

The regulations applied to this zone attempt to conserve the sites while allowing local people to continue to use the land in ways compatible with archaeological protection. Important rules governing the use of Zone 3 include:

- Consent must be obtained from the site management agency for any change in land use including felling trees more than 12 m high, alteration of existing structures or construction of new structures.
- All archaeological finds must be reported to the site management agency.

### 4.2.4 Monument Management Zone

A map of the location of standing monuments and high value (value 5) archaeological sites was produced to aid in defining the boundaries for the Monument Management Zone. To prevent encroachment upon monumental land, it was decided that monument sites, comprising the standing monuments and high value archaeological sites, together with a buffer of 50 m, would be protected. The proposed Zone 4 boundaries are shown in Figure 6.3.

Regulations for Zone 4 include:

- Acquisition of all land comprising Zone 4 by the state and, where appropriate, payment of compensation to private land holders
- No construction
- No habitation
- No cultivation

A draft of the management plan was submitted to the National Inter-Ministerial Coordinating Committee for Vat Phou in March 1998. Consultations were also held with representatives of the provincial and district governments and representatives of villages affected by the plan. Following these consultations, a revised management plan was drafted that was submitted to the Lao PDR government for consideration, amendment and adoption. The plan was officially adopted and approved by the Prime Minister on 28 September 1998.

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### 5 GIS utilization

#### 5.1 Site management

The GIS at Vat Phou was established to assist in the collation, archiving and retrieval of archaeological data collected at the site. This data was used initially to assist in the development of the management plan and will be used in the future for site management.

To manage and protect the site, it is necessary to document the location, nature and quality of all cultural heritage resources. The purpose of creating a cultural resource inventory is to provide information that can be used to assist in the site management decision-making process.

In addition to the uses for site management, the GIS-based cultural resource inventory is of tremendous value to researchers. It enables researchers to access the results of all research already undertaken at the site. Due to the importance of the site, it is anticipated that there will be a continued presence of international research teams at Vat Phou. Data generated by these teams need to be entered into the GIS to ensure that the system contains a complete and up-to-date record of site research.

#### 5.2 Development control

The Vat Phou Heritage Management Authority is responsible for approving or rejecting applications for permission to construct within the protections zones. The agency must monitor the protection zones to identify unauthorized construction and land use...
changes. In addition, they must implement and administer the new regulations contained in the adopted management plan.

GIS can be a valuable tool in assisting with development control. Using the GIS base map and a GPS survey, the site manager can identify in which zone unauthorized or proposed new construction is located and can refer to the zoning regulations. For the plan to be effective, the zoning regulations must be enforced. This necessitates vigilant monitoring of the area by the site management agency and the co-operation of the local community in reporting unauthorized works.

Bibliography

CURCARZI, M.; ZOLESE, P. 1997. An attempt to inventory Khmer monumental remains through geomagnetic modeling: the ancient city of Wat Phu. BEFEO.

Figure 6.1 Ancient City, Champasak, Lao PDR
Figure 6.2 Archaeological sites and standing monuments, Champasak, Lao PDR

Champasak Heritage Management Plan: Study Area
Figure 6.3 Cultural and natural heritage protection zones, Champasak, Lao PDR
Figure 6.4 Vat Phou Temple site plan, Champasak, Lao PDR

Legend

- **Red**: Monuments
- **Green**: Modern structures
- **Blue**: Creek
- **Lines**: Roads
- **Dashed Lines**: Parks and paths
- **Dashed Red Lines**: Embankments
- **Other Lines**: Elevation contours (0.5 m)

Champasak Heritage Management Plan: Vat Phou Temple.
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