

## **Assessment on Local Condition of GIS use in Sustainable Development of World Heritage Site: Case of Luang Prabang, Lao PDR**

### **1. Introduction**

The UNESCO World Heritage Convention was ratified on November 16, 1972. Since then, both public and private sectors around the world have attached growing importance to the safeguarding and conservation of selected cultural and natural objects. The inscription of the world heritage comes with positive and negative implications (Mevrouw, 2008). World Heritage sites receive major publicity and as a result, become notable attractions for large numbers of tourists from all over the world. However, in spite of the clear economic benefits and political prestige, the local governments and communities with little experience face the dilemma to cope with the sudden increase of tourists, and thus, often trigger rapid unplanned development.

Luang Prabang of Lao PDR, inscribed as the World Heritage Site in 1995, is an outstanding example of the fusion of traditional architecture and Lao urban structures with those built with European influences in the 19th and 20th centuries. It has unique and remarkably well-preserved townscape which illustrates the blending of Asian and European distinct cultural traditions. However, the number of tourists grew five times from 53, 800 in 1995 to 275,200 in 2006, since its inscription. As a consequence, the number of accommodations such as hotels and guest houses, restaurants, as well as tour agencies and tourist sites has increased. Among these, the number of guest houses, tour agencies and tourist sites grew the fastest, two times from 2000 to 2006 (Douanphachanh, 2007).

Through collaborative works of Tokyo Institute of Technology (Tokyo Tech), UNESCO, and La Maison du Patrimoine (MdP) as a local representative, the study found a strong need for strategic management of the heritage site by introducing applicable information technology. During the last four years, the joint ICT (Information and Communication Technology) team worked on database establishment for heritage information and the product has been disseminated through the Luang Prabang's first ICT center. As the fourth year of experience, ICT team started looking at Geographical Information System (GIS) as a decision making tool for Luang Prabang. The past GIS related projects in cities and heritage sites in Asia illustrated both positive and negative experiences. Given this background, this paper aims at the following three points: 1) identify the important factors which determine the success and failure of GIS implementation through the analysis of case studies in Asia; 2) analyze the local situation of current GIS usage in Luang Prabang; and 3) identify and suggest the next crucial steps for potential GIS introduction to manage heritage site of Luang Prabang.

### **2. Project background**

The Luang Prabang district has 116 villages and a population of 76,000 with high density of 96 persons per sq. km and population growth of 1.05% (Douanphachanh, 2007). The Luang Prabang town is located within Luang Prabang district. The town is located in the northern central of Lao P.D.R, along the Mekong River about 425km north of Vientiane. The conservation area in the town covers 33 villages. By the end of 2008, Luang Prabang will consolidate from district level to municipal level. The decentralization move means more administration and decision making responsibility to Luang Prabang district.

Tokyo Tech has been collaborating with MdP and UNESCO as a joint research project since 2003. MdP serves as the focal institution for managing the heritage site. MdP, created in 1996 is a national Lao authority, directly reporting to the Ministry of Information Culture (MIC). According to UNESCO recommendations on the inscription of Luang Prabang as World Heritage Site, MdP has four important roles in; 1) controlling, protecting, restoring and embellishing the listed heritage; 2) managing natural conservation; 3) developing the marketplace for local people; and 4) coordinating the relationship with international organizations and relevant donors.



Figure 1. District landscape of conservation area in Luang Prabang  
Source: ICT Center, Luang Prabang

Through the joint research project, five components were identified as most needed areas for introduction of ICT, namely; 1) establishment of database management system; 2) testing of network connectivity; 3) development of website; 4) development of ICT centers; and 5) training of local human resources. This collaboration has resulted in successfully establishing first ICT center which offers a comprehensive information database on inscribed heritage objects of Luang Prabang. The databases system features the following characteristics; 1) web based interface to share information in IP network; 2) free and open source software (FOSS) in consideration of legal copyrights and cost efficiency for sustainable use purposes; and 3) multi language support where Lao language is needed for local people's use and other languages for visitors (Yamaguchi et al., 2007).

### 3. Analysis of Case Studies of GIS introduction in Asia

Experience of Luang Prabang as a world heritage site in developing country is unique on its own. This requires study to identify the important factors of practical GIS implementation in world heritage sites and urban cities in Asia. Although administration and institutional arrangements differ from country to country, it is significant to discuss some common factors influencing technological, managerial and institutional issues when adopting GIS in the World Heritage Sites in developing countries. In this section, the analysis of case studies includes Hue of Vietnam, Plains of Jars and Vat Phou of Lao PDR, Bangkok of Thailand and Cebu of the Philippines. There is a range of GIS implementation strategies adopted in these cases. In each case, major factors which determine the success and failure of GIS introduction are illustrated in Table 1.

The five case studies selected have different background in economic, social, institutional, legal and technical environment aspects. Though it is difficult to generalize, common factors which affect the GIS introduction can be observed. Significant factors are identified as the following six points: 1) High level of awareness and management support is present; 2) Dedicated and committed local human resources are established; 3) Data are available to make GIS fully functional and standardized to allow sharing; 4) Internal and external coordinations are successfully exercised in organizations; 5) Sustainable usage of GIS is continuously emphasized; and 6) Appropriateness of the scale of implementation to reflect the objectives of GIS is well analyzed.

Table 1. Summary of Case Studies: Important factors to be considered for sustainable GIS operation.

<b>Place</b>	<b>Purpose of GIS</b>	<b>Successful factors</b>	<b>Barrier factors</b>
<p><b>Hue, Vietnam</b></p> <ul style="list-style-type: none"> <li>• The World Heritage site located in Thua Thien Hue Province in the central of Vietnam.</li> <li>• The Imperial city of Hue with its own Forbidden Purple City built in 1802 possesses a unique architecture.</li> <li>• Structure is deteriorating due to climate, prolonged period of war and lack of funding for restoration.</li> <li>• Project aims at protection, conservation and enhancement of site's cultural resources.</li> </ul>	<ul style="list-style-type: none"> <li>• Assist in micro management of Hue Monuments Complex                             <ul style="list-style-type: none"> <li>○ Produce inventory of cultural heritage resources and their constituent parts,</li> <li>○ Analyze, manage, and visualize of structure condition,</li> <li>○ Assess needs of prioritizing resources for maintenance, conservation and restoration.</li> </ul> </li> <li>• Assist in macro management in managing cultural resources within the context of Hue cultural landscape                             <ul style="list-style-type: none"> <li>○ Management of urban area of Hue through analyzing land use, demographic data and development plans,</li> <li>○ Management of the cultural landscape of Hue through analyzing land use, heritage protection zones and regional development plan zones.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Selected the appropriate GIS software according to the users' needs and beginner level of experience.</li> <li>• Fully utilized local experts to conduct gradual and locally based GIS training</li> <li>• Did not relied on vendor support by using locally developed GIS software called DBMap, by Institute of Information Technology (IOIT) in Vietnam.</li> <li>• Cost effective.</li> </ul>	<ul style="list-style-type: none"> <li>• Limited finance to generate spatial data and maps.</li> <li>• Lack of data availability and map sources at different scales for regional, urban and site planning purposes.</li> </ul>
<p><b>Plain of Jars, Lao P.D.R.</b></p> <ul style="list-style-type: none"> <li>• The site nominated as a World Heritage site is located in Xieng Khouang, South of Lao.</li> <li>• The Jars are believed to be mortuary vessels, date back to 500 B.C – 500 A.D.</li> <li>• The area suffered heavy aerial bombardment during Vietnam War.</li> <li>• Project aims at creating heritage inventory</li> </ul>	<ul style="list-style-type: none"> <li>• Define map boundaries for most frequently visited jar field sites to request clearance of unexploded ordnance.</li> </ul>	<ul style="list-style-type: none"> <li>• Successfully integrated cartographic map data with different scales through cooperation of four agencies.</li> <li>• Collected data and field survey achieved through participatory approach by training and mobilizing local district officers and village chiefs.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of suitable and available topographic maps</li> <li>• Generate spatial data at different scales consume high cost.</li> </ul>

Table 1. Summary of Case Studies: Important factors to be considered for sustainable GIS operation (cont')

<b>Place</b>	<b>Purpose of GIS</b>	<b>Successful factors</b>	<b>Barrier factors</b>
<p><b>Vat Phou, Lao.P.D.R.</b></p> <ul style="list-style-type: none"> <li>• The world heritage site is located in the Southeast of Lao.</li> <li>• It is a Hindu-Buddhist sanctuary of the Khmer Empire period, spanned from 9<sup>th</sup> to 13<sup>th</sup> century.</li> <li>• Project aims at developing heritage protection zone strategy of the site.</li> </ul>	<ul style="list-style-type: none"> <li>• Collect archive archeological, geological, demographic, land use and hydrological data.</li> <li>• Analyze data collected to develop heritage protection zone strategy for the site.</li> </ul>	<ul style="list-style-type: none"> <li>• Selected appropriate GIS software according to the users' needs, ability and good vendor support.</li> <li>• Utilized standardized data format to be compatible with other local departments to encourage sharing and integrating spatial data.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of full time and dedicated local GIS personnel to continuously update the data.</li> </ul>
<p><b>Bangkok, Thailand</b></p> <ul style="list-style-type: none"> <li>• Bangkok Metropolitan Administration (BMA) initiated Bangkok Land Information System (BLIS) project from 1989 till 1991.</li> <li>• The project aim at long term strategy development of BLIS.</li> </ul>	<ul style="list-style-type: none"> <li>• Produce a base map common for BLIS project and analyze data collected for long term planning strategy of Bangkok such as garbage disposal management, demand of primary education in districts, and different districts population density for policy making.</li> </ul>	<ul style="list-style-type: none"> <li>• Presence of high level of awareness and management support in integrating information from different local departments.</li> <li>• Encourage interagency collaboration.</li> <li>• Emphasized GIS training program to educate, train and provide experience to local officials.</li> </ul>	<ul style="list-style-type: none"> <li>• Consume high cost, long time and administratively complicated to develop large scale digital map.</li> </ul>
<p><b>Cebu, Philippines</b></p> <ul style="list-style-type: none"> <li>• Cebu Province established a GIS center which provides services and GIS products to local clients with the support from German Agency for Technical Cooperation (GTZ).</li> </ul>	<ul style="list-style-type: none"> <li>• Produce and update digital data and maps.</li> </ul>	<ul style="list-style-type: none"> <li>• Presence of high level of awareness and management support for continuous development of GIS.</li> <li>• Promoted information flow from different sources.</li> </ul>	<ul style="list-style-type: none"> <li>• Limited funds to generate and maintain spatial data.</li> <li>• Lack of qualified GIS local staff and high turnover due low salaries.</li> </ul>

Source: Summary of analysis of case studies of GIS introduction in Asia, 2008

**1) High level of awareness and management support is present:** High level of awareness and management support is identified as one of the most important factors. In the context of developing countries, the successful implementation and use of spatial information infrastructures are strongly dependent on political and institutional support. Management support is necessary in building solid infrastructure by understanding the limitations and providing the necessary flow of information to the system. In the case of Bangkok, the project only received necessary political support after the expert in charge was seconded as the deputy governor to the Bangkok Metropolitan Administration (Bishop et al., 2000). In the first few years of GIS project in Cebu case, the project suffered from lack of financial buffers and high turnover of staff due to low salaries and poor work conditions compared with the private sectors. However, with the strong management support, the project had finally overcome the difficulties and succeeded in establishing Geoplan Cebu Foundation. This Foundation was able to gain more decision making responsibility, functioned independently from administration of province government and flexible in offering services and products on GIS market (Vegt, 2001)

**2) Dedicated and committed local human resources are established:** Local human resources are the key to fully utilize appropriate technology, maintain the system and update data. Therefore, the availability of local human resources is the important factor. Strong team of full-time dedicated local professionals needs to be established. In the case of Vat Phou, Lao P.D.R., a small team of Lao archeologist, museum specialist and conservator was formed and trained. However, they were not assigned as full-time GIS operators and the team members had other duties and responsibilities. This situation led to lack of continuity of data processing and management (Box, 1999). Both cases of Vat Phou, Lao P.D.R, and Hue, Vietnam, appropriate software packages were selected based on the users' ability and needs. Software for the beginner level was used and it satisfied the users' needs though it lacked in spatial data analysis functions. In Hue, Vietnam, local experts from the Institute of Information Technology in Vietnam fully contributed to conduct gradual local GIS training (Box, 1999). There is a need for very substantial training development program aimed at raising and maintaining skills.

**3) Data are available to make GIS fully functional and standardized to allow sharing:** In developing countries, appropriate maps are scarce. Appropriate data as well are difficult to obtain in digital form and base maps are often outdated or nonexistent. Even when spatial data are in digital form, few results were derived. It is important to start with basic data collection in order to have an effective and efficient GIS operation. This requires time and cost which few people are willing to commit as the benefits may not be immediate. In case of Plain of Jars, Lao P.D.R., producing a base map even for a limited area faced a problem due to lack of suitable topographic map. Spatial data generation is very costly. Thus, the project is only feasible if base map or data generated by third party can be procured for little or no cost. The project had to incorporate data from four different local departments at different scales (Box, 2003). Appropriate data standards are crucial to ensure compatibility of data, to encourage sharing of data and to reduce data redundancies. However, it is difficult to obtain consensus due to different institutional needs. The organization which leads in establishing data standards, deciding on the scales and constantly updating data is often lacking in developing countries.

**4) Internal and external coordinations are successfully exercised in the organizations:** Another commonly observed factor is the importance of institutional coordination with GIS implementation. The decision to implement a large-scale GIS has greater consequences in terms of organizational change. Implementation of GIS to support the objectives of a specific department may cause lower impact to the other departments and restricts the availability of data and limits inter-departmental coordination. Regardless of the scale of implementation, the GIS system must be able to integrate with existing information management procedures. Plain of Jars, Lao P.D.R. was able to adapt GIS intervention into

current system and integrated four different departments' maps. Thus, this enhanced the interagency collaboration to achieve mutually beneficial development objectives. The Plain of Jars project was conceived as a collaborative effort to safeguard the cultural resources of the site together with the lives of local inhabitants and tourists. However, not all the cases were successful in adapting GIS into the organization structure. One such example is the case of Bangkok, Thailand. Although a common interest existed in producing base map, urban planners and utilities agencies had different point of views on map requirement and needs of different scales. At the same time, there was a lack of understanding on technology concepts of GIS system. The conflict of interest, lack of understanding and misconception gave rise to unnecessary competition among the government agencies who were participating in Bangkok Land Information System (BLIS) project. The agencies were considering their own interests as they were competing for budgets to develop their own computerized systems which were independent from BLIS project (Bishop et al., 2000).

**5) Sustainable usage of GIS is continuously emphasized:** Sustainable use of GIS requires three aspects to be fulfilled; 1) operational cost and cost incurred for future development of the system; 2) training program to assist and guide GIS users who are facing changing technologies to continuously utilize GIS; and 3) maintenance of the system with constant updating of data. In the cases mentioned above, these aspects are discussed extensively. The three aspects are dependent on each other and it was observed that sustainable usage of GIS system will face the difficulty if one of the three is missing. The GIS introduction and training in cases studies except for Bangkok, were initiated and funded by foreign aid organizations. Once the project has completed, it is difficult to sustain the necessary operational cost without foreign aid organizations since the GIS software maintenance and licensing fees are often costly. All cases relied on vendor support except for Hue of Vietnam. The sustainable GIS use requires financial support from the government and it could incur high cost if the system totally depends on the vendor's support. In Hue, Vietnam, the case enjoyed considerable success due to the fact that all three aspects are fulfilled. Low cost was incurred due to self developed GIS software by the Institute of Information Technology (IOIT) and locally based training. The local experts from IOIT, being sensitive to the users' lack of experience and educational level, designed a gradual training program to ensure smooth learning process for the users. Though the software did not include spatial analysis functions, the users' needs were satisfied and it encouraged a continuous data updating. Data maintenance requires solid financial resources and commitment of human resources.

**6) Scale of implementation to reflect the objectives of GIS is well analyzed:** The scale of GIS implementation in developing countries makes a difference on degree of success. The GIS system utilizes a base map which requires a large amount of cost and effort to generate spatial data. Many government agencies in developing countries do not possess quality base map or it is often the case that appropriate data are not available. In the case of Bangkok, Bangkok Metropolitan Administration (BMA) aimed to develop large scale digital map. It was mentioned in the case, after nearly a decade of struggle, although BMA has realized that GIS is an effective tool for planning and managing urban infrastructure, the development and maintenance of a large common digital base map has not been realized. It is now recognized as costly and administratively complicated. Therefore, it is likely that starting with smaller scale implementation of specific usage and simple analysis are more convincing. Operational cost and initial investment are also likely to be recovered though short term benefits and such a concrete good example can encourage expanded use of GIS. These small or medium scale projects are good options to introduce GIS concept in developing countries to convince decision makers and to gather wide range of supporters for introducing such technologies.

#### **4. Analysis of Current GIS use in Luang Prabang**

The Luang Prabang district is now under the process of attaining municipality status by the end of 2008. With the new status, the district will consolidate 68 villages and more decision making responsibility will be given to the district. Introduction of GIS is now being considered by the joint team of MdP and Tokyo Tech as a possible tool for effective management of the heritage sites as well as urban town management. In the past, some local government offices tried to introduce GIS on the trial bases, but such trials were on ad hoc bases and were not planned with long term objectives. This section aims to illustrate the current local situation on how GIS is being used locally. Further, based on the study conducted in Luang Prabang, this section summarizes major findings and identifies potential problems when considering larger scale of GIS introduction.

### **Assessment Methodology**

The study was conducted to assess current needs in introducing GIS, focusing on the following points. Category of questions includes 1) reasons to introduce GIS, 2) specific GIS software utilized and reason for its use, 3) level of current performance of GIS usage, 4) level of efficiency, and 5) perception of users and upper management towards GIS. To gather information, the three methods were used.

#### ***1) Interviews with engineers (users), directors of local departments, and National Geographic Department (NDG)***

The extensive interviews were conducted at different levels of local government departments concerned. It was carried out with the purpose to collect views of different hierarchies of local government, who possess different roles and responsibilities. A total of 29 engineers and top level management such as directors and deputy directors from 12 departments were interviewed. Careful consideration was given to the fact that top management often has little knowledge of GIS as well as other technologies. They may have difficulties to comprehend the benefits and risks of GIS. Hence, introduction and examples of GIS applications were presented at the beginning of the interview. National Geographic Department is the only organization to produce and manage data of fundamental geographical information in Lao P.D.R. The purpose of the interview at NGD was to understand the background of data collection, how the data is collected by the department, the role of geographical information system in Lao and policies enforced by the department to propel the use of spatial data.

#### ***2) Questionnaires***

Written questionnaires were given at a local GIS workshop to eight engineers who use GIS. In addition, top level management of local government who attended local symposium on Heritage Management and ICT application in Luang Prabang, responded to the questionnaires. The questionnaires focused on the following issues; 1) how the engineers and top level management perceive GIS, 2) level of receptiveness and awareness towards the technology, 3) GIS benefits in their work, 4) potential challenges in using GIS, and 5) insight and local experience in determining the important aspects for future GIS applications.

#### ***3) Discussion at the local symposium***

MdP and Tokyo Tech team organized a local symposium in December 2007. The symposium aimed at sharing ICT project achievement as well as introducing potential GIS applications in the future. The 14 participants include representatives of MdP, UDAA (Urban Development Administration Authority), Luang Prabang District, STEA Vientiane (Science, Technology and Environment Agency), STEA Luang Prabang, Souphanouvong University, Tourism Department, DCTPC (Department of Communication, Transport, Post and Construction) and Land Department. This is recognized as a gathering of decision makers of Luang Prabang and thus, is indicated high interest of government officials of Luang Prabang. The proactive discussion with decision makers was useful to discover their interest and level of support towards GIS implementation.

**Analysis of current situation**

Through interviews, the result of questionnaires and discussion, expected and unexpected findings were uncovered. This section summaries the major findings.

**1) Benefits of GIS are recognized by both engineers and top level management:** The engineers utilized GIS in their work because it was necessary and easy to report their work results to the superiors. All the users recognized the GIS benefits, as it could enhance their work and useful for the management to comprehend their work outcomes. Top level management recognized GIS can be utilized to manage their work efficiently. More importantly, they felt that GIS can improve the development activities and management of preservation of Luang Prabang. They have identified various areas of potential GIS application in forest management for conservation purposes and agricultural land use, management of domestic production, ecotourism and heritage management, and impact measurement of hydro power plants and alternative energy use on environment. All top level management identified the government decision and full support as the most vital factor for successful GIS (Figure 2). Following Lao unique history and political background, government acts as the central decision maker and local government are totally dependent on its decision. Further, they also recognized the importance of clear and specific purpose and maintenance of GIS system in determining the success of GIS.

**Rating of Four Key Factor in Introducing GIS**

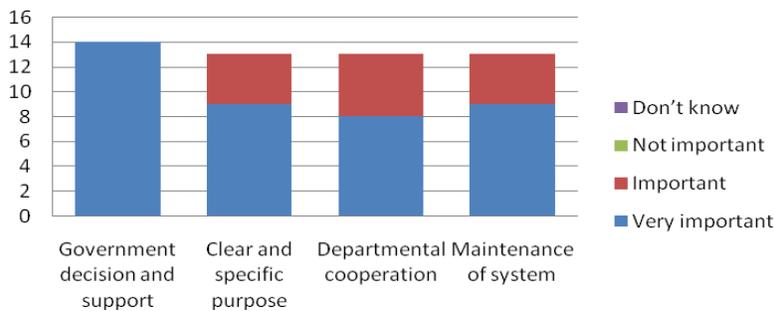


Figure 2. Rating of importance of four key factors in introducing GIS  
 Source: Result of questionnaires conducted at the Local symposium, Luang Prabang, Lao P.D.R., December 2007

**3) GIS utilization is constrained by non technical and technical limitations**

In spite of the fact that all engineers and top level management showed high interest in GIS use, they were concerned about the successful use of GIS. The engineers could not fully experience the full benefits and risks of GIS due to lack of experience, inaccuracy of Global Positioning System (GPS) for location data in the recording field, limitation of functions of outdated software and discrepancy of data accuracy in commonly used base maps. Engineers were questioning on the accuracy of different base maps used in GIS which originated from two sources, 1982 Russian map scaled 1:100,000 and 1964 American map scaled 1:50,000. Engineers used the maps according to the area they were assigned following their work description. The 1982 Russian map provides an overall good map, however the 1964 American map drawn during the Indo China war, is more detailed and includes detail routes to the small villages. The two maps have difference in the order of few hundred meters posed a major problem since both maps are widely used in many local departments. The base map provided by NGD is drawn from the 1982 Russian map. Engineers from DCTPC, Forestry and Land Property highlighted the importance of accurate data as well as updating the data. Accurate data sharing is an important premise for effective

GIS introduction. The top level management assumes that GIS use is not yet prevailed due to lack of funds, insufficient experienced technical personnel and unavailability of facilities.

**4) Clear objectives of GIS use are not shared in the department:** Within a department level, responsibility and objectives in using GIS were unclear, thus making it more difficult for the engineers to work efficiently. The engineer from the Department of Irrigation highlighted that communication on the clear objectives for using GIS from higher level management is crucial for efficient and coordination within the department. Moreover, there was a gap in knowledge between the top level managements and engineers. It was quite common that the superiors did not know that the engineers were using GIS within the department.

**5) Desire to learn and share information is present:** Both engineers and top level management from different departments were keen and willing to share information with other users to reduce redundant data generation and learn from each other. The engineers even suggested to share data via the inter-department network established through the GIS workshop. Even at top level management, eight of thirteen respondents indicated that departmental cooperation to be important for GIS implementation. It was found that each engineer received software and training independently, and did not have the opportunity to share their tasks and experiences of GIS with engineers of the other departments.

### **Problem Identification**

Based on the analysis of the current situation of Luang Prabang, this section tries to identify problems the engineers and top management of the departments are facing when considering an effective GIS introduction:

**1) Concrete policy of Luang Prabang Government in GIS use is not present:** There are eleven engineers who use GIS in Luang Prabang but they are all independent users as shown in Figure 3. They have different reasons in using GIS. Experiences of the users ranged from 1 month to 3 years and skill levels were all different in using GIS. Most of the engineers are still young and at the beginners level. In addition, they used different GIS software and sometimes a combination of two GIS software according to the training received. The data sets were not updated. Obviously GIS was not introduced in line with specific policies of the department nor Luang Prabang Government. This could mean change of management personnel in the department may lead to sudden suspension of GIS utilization.

**2) Users' needs are not identified:** Although GIS utilization varied from department to department, it was clear that its use so far is limited to cartographic and does not include spatial analysis in any department of the local government. However, upper level management may expect needs beyond cartographic use. For example, the MdP in urban agriculture which referred to crops cultivated within boundaries of the city, collected GPS data of land use and attribute data, but no analysis has been done using collected data so far. The interviews revealed that users were much concerned about technical side of GIS rather than specific application. Clear needs identification is the first important step to attain effective use of GIS. Once such objectives are decided, discussion on types of software, including comparison between FOSS and commercial software becomes realistic.

**3) Availability of appropriate data is in question:** The survey revealed that the departments and users misunderstood the cost related to GIS introduction. Majority considered the high cost of GIS software but the costs related to data collection and its maintenance were often underestimated. FOSS GIS software itself may be free of charge, however, the raw data to be utilized for GIS requires time and effort. The base map can be bought from the NGD and specific data obtained from agencies or through manual labor of land survey. And such cost needs to be considered at the planning stage. As for the heritage

data in Luang Prabang, location maps of heritage buildings, temples, public spaces and roads were not updated since the original map was created in 1999/2000. Other maps such as topographic and aerial map suffered similar condition. There is lack of digitized data of the protected area. Data source and timeline varied from department to department. For example, the Department of Irrigation, an exception among other departments who used NGD base map, utilized base map scanned from 1983 atlas map and updated data till 2006 while DCTPC used NGD base map and updated data till 2000. Such data was incompatible and difficult to share with other users. The accurate analysis using GIS totally depends on updated data.

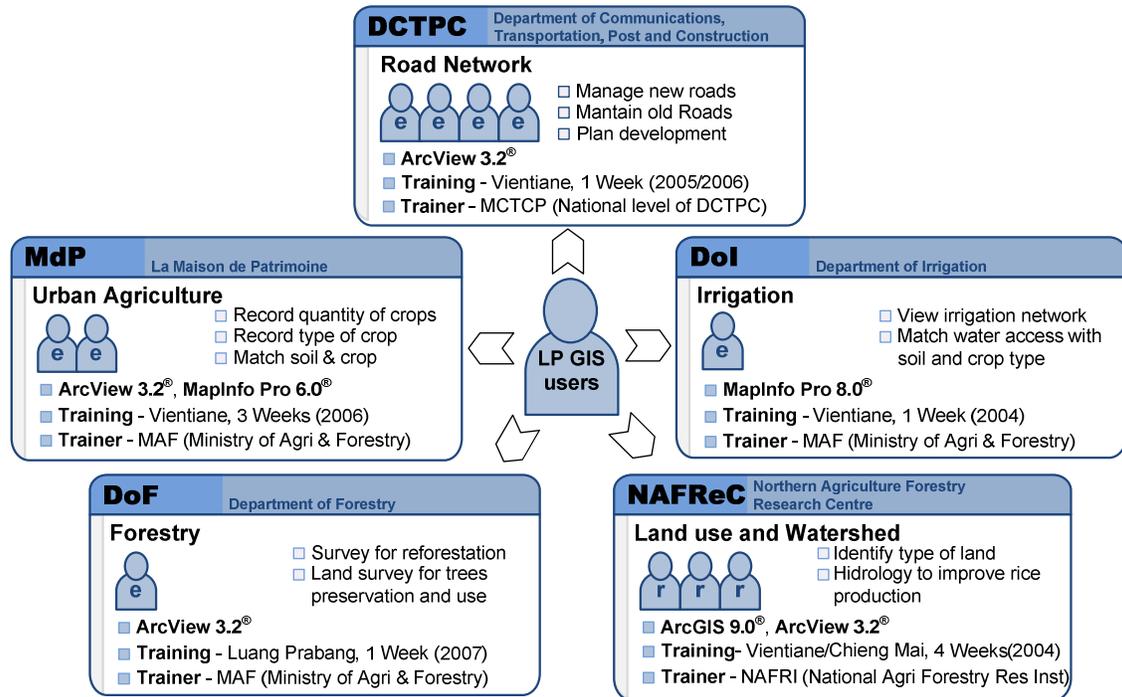


Figure 3. The diversity of current GIS usage in Luang Prabang is described in different fields, amount of experience and GIS solutions used in five departments.

Source: Analysis of interviews and questionnaires conducted in Luang Prabang, 2007

**4) Common platform among users of different departments is missing:** A common platform to be shared by different departments is important for standardizing and unified the GIS use. Platform here refers to a place to facilitate sharing of data. Through common platform, standardization of GIS use, inter-department cooperation and information sharing will be easier and effective. In the interviews, each department identified the information need to be collected from the areas. For example, DCTPC required priority information of demographic, local transportation, road and bridge networks, and secondary information from temples, soil type, and law and regulations. Meanwhile, MdP also required overlapping information of temples, law and regulations, demographic data as well as road and bridge information. From the interviews, it was obvious individual department require data sets from multiple fields in order to fully utilize GIS and to derive the necessary information. Currently no data sharing was promoted among the departments even though they have overlapping interest and needs for data collection.

**5) National policy on geographic data has not been disseminated at the local level:** In use of mapping activities in Lao PDR, the decree of Prime Minister Office No.255 ensures that a unified system officially promulgated by government is expected to be exercised throughout the country by 2010. The mapping activities refer to the activity of producing maps based on existing layers of information to display geographical data with indicators.

The unified system implies to the administration and management plans, technique, quality, data and equipments adhere to technical instruction outlined by the government. The National Geographic Department is responsible for the enforcement of this decree. However, it was obviously a top down approach, and degree of understanding and how this policy was communicated to the local level is in question. The interviews and discussion taken place in Luang Prabang illustrated gaps in use of base maps and GIS data. At least in Luang Prabang, such policy has not been implemented effectively. Only after the policies on GIS use is discussed and recognized between central government and local government users, it is possible to realize effective and sustainable GIS introduction nationwide.

## 5. Discussion

The analysis on the current situation of GIS use in Luang Prabang provides a clear picture of what is lacking to realize effective and sustainable GIS introduction. Four most important steps are identified to consolidate GIS implementation.

**1) Identify the clearer users' needs and purpose of GIS introduction:** The current use of GIS in Luang Prabang is limited to cartographic use. It is important to discuss the necessity of spatial analysis of data. Proper needs assessment is required with specific local departments who are potential GIS users. The clear and specific purpose of GIS usage is a basic requirement. Only after it is determined, the scale of GIS implementation can be decided accordingly, (e.g. new municipal area vs. core heritage preservation zone).

**2) Identify source of data:** Throughout the assessment exercise, it was highlighted that data source for GIS is a crucial issue for an effective and realistic GIS use. Where and how to obtain data is vital, given that cost related to data collection and its maintenance are often underestimated. Currently, the base maps can be obtained from the NGD. Another source of maps is from Safeguarding and Preservation Plan (PSMV) dated 1999. PSMV was initiated by the French Government and UNESCO, as a regulatory tool for managing heritage site within the scope of protection defined by UNSECO. The PSMV map provides more detailed information on inscribed heritage objects in protected zone. Thus, Luang Prabang Government needs to decide on data source in early stage of planning.

**3) Identify the appropriate GIS software:** Discussion often concentrates on whether FOSS or commercial GIS software to be used in Luang Prabang, provided that sustainable aspect of GIS introduction is vital. The cost incurred for its introduction and maintenance is also crucial. Particularly, the following three aspects need to be carefully considered: 1) users' needs; 2) relatively easy functions for the users to manipulate and maintain the system; 3) low cost required to sustain its operation, and 4) compatibility to the unified system expected to be in exercise by 2010 as a national policy.

**4) Establish training program and policy for local GIS team:** Learning from the lesson of case studies, it is important to form a dedicated GIS team with full time members to manage and maintain effective GIS operation. Training program should be designed to assist members reflecting rapidly changing technologies. Commitment by the Luang Prabang Government is basic but important condition for its sustainable GIS development.

## 6. Conclusion

The paper examined the appropriate approaches to be taken in introducing GIS in Luang Prabang as a decision making tool. The analysis of common factors observed in GIS introduction in Asian cities and world heritage sites was first introduced. Then based on such analysis the local condition of GIS usage in Luang Prabang was closely looked at. An

extensive interviews, questionnaires were carried out among engineers and its top management of the relevant local departments. The analysis of the current situation identified several problems: 1) concrete policy of Luang Prabang Government in GIS usage is not present; 2) users' needs are not identified; 3) availability of appropriate data is in question; 4) common platform among users of different departments is missing; and 5) national policy on geographic data has not been disseminated at local level. Given such condition, the authors tried to identify and suggest the four steps to be taken when considering an effective and sustainable introduction of GIS in Luang Prabang. They are: 1) clear identification of users' needs; 2) identification of proper data source; 3) identification of appropriate GIS software; 4) establishment of training program for local GIS users. Such steps need to be understood and fully supported by the top management of Luang Prabang Government. Analysis of cases in Asia illustrates the importance of awareness and support of the high level management to propel GIS introduction. Further, formation of dedicated local team as well as data availability become premise for successful GIS operation. Standardization of data to allow data sharing among different users also needs to be considered. Luang Prabang is recognized as a significant world heritage site in Lao P.D.R. The authors hope to see the steps above mentioned to be taken with the initiatives of the local government and institutions concerned in the near future to realize sustainable development of Luang Prabang.

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Ceelia Leong, PhD candidate, Japan

## Authors:

Ceelia Leong, Shinobu Yume Yamaguchi and Jun-ichi Takada  
Tokyo Institute of Technology