From Low-Cost to Open Source: Choices and Challenges for the Cambodian Land Registration System

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Key words: Digital cadastre, Low cost technology, Open source software

SUMMARY

From the start, the development of the Cambodian land registration system has sought to apply low-cost technology to a maximum of functionality. In a country where a large part of the population lives on less than a dollar per day, spending public money on state-of-the-art IT systems can hardly be justified. Using inexpensive software and locally developed interfaces, the land registration system of the Land Management and Administration Project (LMAP) has facilitated the systematic registration of over 1 million land parcels in five years. However, as data volumes and demands for data sharing increase, LMAP must look ahead and modernize its system to meet future requirements.

Open source software products, available at no cost, provide a good alternative to proprietary software, especially in poor countries like Cambodia. The amounts of money that are saved on software license fees can be channeled towards development and maintenance, thus towards building a system that is better adapted to local requirements. This paper looks at the development of the Cambodian land registration system under Component 3 – Land Titling Program and Development of a Modern land Registration System of the LMAP project, supported by the government of Finland, and the role that open source software can play.

គោរពជូនយោបល់សង្ខេប (SUMMARY IN KHMER)

តាំងពីដំបូងមក ប្រព័ន្ធចុះបញ្ជីដីធ្លីរបស់ប្រទេសកម្ពុជា ត្រូវបានអភិវឌ្ឍដោយប្រើប្រាស់បច្ចេក-
វិទ្យាដែលមានតម្លៃថោក ប៉ុន្តែមានផលិតភាពខ្ពស់បំផុត ។ ចំពោះប្រទេសមួយដែលប្រជាជនភាគច្រើន
កំពុងរស់នៅដោយពឹងផ្អែកលើប្រាច់ចំណូលទាបជាង ១ ដុល្លារក្នុងមួយថ្ងៃ ការចំណាយថវិការដ្ឋលើ
បច្ចេកវិទ្យាព័ត៌មានវិទ្យាដ៏ទំនើប ពិតជាមិនស័កសមឡើយ ។ ហេតុដូចនេះហើយ ប្រព័ន្ធចុះបញ្ជី ដីធ្លី
នៃគំរោងរៀបចំដែនដី និងរដ្ឋបាលដីធ្លី (LMAP) បាមសម្របសម្រួលការងារចុះបញ្ជីដីធ្លីមានលក្ខណៈ ជាប្រព័ន្ធ
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កម្មវិធីមូលដ្ឋានទិន្នន័យដែលអភិវឌ្ឍឡើងនៅក្នុងប្រទេស ។ ទោះយ៉ាងណាក៏ដោយ ដោយសារបរិមាណ ទិន្នន័យ

និងតម្រូវការទិន្នន័យមានការកើនឡើង គំរោង LMAP ត្រូវសម្លឹងមើលទៅមុខ និងធ្វើទំនើប
ភាវូបនីយកម្មប្រព័ន្ធបច្ចេកវិទ្យាព័ត៌មានវិទ្យារបស់ខ្លួន ដើម្បីស្របតាមតម្រូវការនាពេលអនាគត ។

កម្រងកម្មវិធីកុំព្យូទ័រប្រភពបើកចំហ ដែលអាចរកបានដោយមិនគិតថ្លៃ ជាជម្រើសដ៏ល្អមួយ ជា
ពិសេសចំពោះប្រទេសក្រីក្រ ដូចជាកម្ពុជា ។ ចំនួនថវិការដែលសន្សំបានពីថ្លៃអាជ្ញាប័ណ្ណកម្រងកម្មវិធី កុំព្យូទ័រ
អាចយកទៅប្រើប្រាស់សម្រាប់ការអភិវឌ្ឍន៍ និងតំហៅទាំ ពោលគឺជួយបង្កើនប្រព័ន្ធអោយមាន
លក្ខណៈកាន់តែប្រសើរស្របតាមតម្រូវការក្នុងប្រទេស ។ សេចក្តីជូនយោបល់សង្ខេបនេះ បានប្រមើល
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គាំទ្រដោយរដ្ឋាភិបាលប្រទេសហ្វាំងឡង់ និងប្រមើលមើលពីវិសាលភាពរបស់កម្រងកម្មវិធីកំព្យូទ័រដែល
មានប្រភពបើកចំហ ។

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1. INTRODUCTION

Like in many developing countries, it takes time to get things done in Cambodia. It took eight months to get a shipment of software upgrades out of the customs facility at Phnom Penh airport. Those were free upgrades, promised with the purchase of the previous version of the software the year before. However, the customs authorities required the payment of import tax before the shipment could be released, and were hard to convince that the software upgrades had no commercial value. Cambodia is one of the poorest countries in South East Asia, with many people living on less than a dollar per day. Agriculture is the most important economic sector, with rice farming as the most common rural occupation. During the Khmer Rouge regime in the 1970s, all land records were destroyed. Now, a land register is being built up from scratch through systematic land registration, village by village, commune by commune, district by district, province by province. Each month, around 25,000 land parcels are registered through a digital land registration system. Computers and software licenses have been bought to equip land registration teams in 15 provinces. The costs to maintain the system and to meet future demands in terms of data volume and user requirements are considerable. The idea of using of open source software as an alternative to proprietary database and GIS software is met with enthusiasm, and efforts are underway to implement open source solutions. The obvious financial benefit is one of the reasons why open source solutions are popular in Cambodia. However, the cost of software licenses is probably the least of the many problems that the Cambodian cadastre is facing.

2. LAND REGISTRATION IN CAMBODIA

2.1 A good start

Even though Cambodia is one of the poorest countries in the region, its government managed to initiate land registration successfully using a digital system. After several pilot projects, the Cambodian Ministry of Land Management, Urban Planning and Construction (MLMUPC) started to implement systematic land registration in 2002 under the Land Management and Administration Project (LMAP) supported by the World Bank and the governments of Finland and Germany. The main component of the project, supported by the government of Finland, aimed at the surveying and adjudication of 1 million land parcels and the issuing of land titles for at least 80% of the surveyed parcels (World Bank, 2002). By the end of 2007, this ambitious goal had been reached and surpassed. Currently, over 1.5 million land parcels have been surveyed and adjudicated and for most of these, land titles have been issued to the owners. Monthly progress is steady and land records are processed and updated in decentralized digital databases in provincial cadastre offices. Sale transfers, subdivisions and consolidations are digitally registered as well.

As in many other land registration projects, the Cambodian digital land registration system is based on MS Access and the ArcView edition of ESRI ArcGIS; low-cost solutions that are relatively easy to implement. Customized cadastre tools and a Khmer interface have been developed locally with technical support of the Finnish government through FINNMAP. The idea has been to start with simple tools that can be upgraded and extended later on when data volumes, local technical capacity and user requirements increase.

2.2 Challenges

Now, seven years after the start of the systematic land registration under LMAP, data volumes and requirements have increased indeed. The MS Access databases can no longer handle the increasing amount of data and transactions. The hardware was bought in 2002 and needs replacement, but procurement procedures of the World Bank-financed project are complicated and inefficient. Local technical capacity has not kept up, and IT expertise within the MLMUPC almost non-existent. The MLMUPC finds it hard to contract and keep skilled Cambodian Information Technology (IT) experts in the civil service, and still relies largely on foreign technical support. Lack of funds to finance proprietary software licenses is probably the least of all IT problems that the project faces. Thanks to international support, the MLMUPC has funds available for software and hardware. In fact, the cost of the systematic land registration was calculated to be only 9 USD per title, less than a third of the projected cost (World Bank, 2009). Also, the land registration activities are generating income through taxes on the transfer of land parcels. In theory, the incoming funds from land transfer taxes would be more than enough to finance the land registration activities and if channelled to the MLMUPC, it could afford buying proprietary software licenses. Therefore, the money argument alone is not enough to justify the use of open source software. There are other reasons why the introduction of open source database and GIS software would bring considerable advantages for land registration activities in Cambodia.

2.3 From MS Access to PostgreSQL

Up to now, Cambodian land register data has been kept in MS Access databases with the expectation that the data could be migrated to more powerful database software as the data volume grows. One of the useful functions of MS Access is that it can link to back-end databases in other formats through ODBC (Open Database Connectivity). In that way, the ease of the MS Access interface can be combined with the reliability of more powerful database software to form an efficient database system. Among the evaluated options were Oracle and SQL Server. Both options can be quite expensive if choosing the enterprise edition, but free “express” editions are available that will work in small settings and with database sizes up to a certain limit. The downside is, when the data volume grows and the number of users increases, it will be necessary to upgrade to the paid versions eventually.

Open source database software offers a better choice. PostgreSQL, which is considered the most advanced open source database software, has grown in sophistication and reliability and is now used by many large companies for mission critical operations. The maximum amount of data that can be stored in PostgreSQL databases is as yet unknown, but databases that store

multiple terabytes of data are not uncommon. With the spatial extension PostGIS, which is also open source, also geographic datasets can be stored in PostgreSQL. The powerful database capacities combined with spatial functions make PostgreSQL especially suitable for land registration projects such as LMAP.

Migrating from MS Access to PostgreSQL may seem a daunting task, but is in reality rather easy. There are not many conversion tools for PostgreSQL available, but most of the conversion work can be done simply by copying data from the Access tables into the linked PostgreSQL tables. For the Cambodian Land Register databases, the following procedure is followed. To begin with, a table structure was created in PostgreSQL. This can be done through the PgAdmin interface that lets users create database tables with columns, restrictions and indices. The table structure created for the Cambodian Land Register was almost identical to the tables in MS Access, with a few differences in data types. The table below shows how MS Access data types used for the LMAP land registration database translated to PostgreSQL data types.

MS Access data type	PostgreSQL data type
Text	Character
Integer	Integer
Long Integer	Bigint
Byte	Smallint
Date	Date / Time / Timestamp
Memo	Text
Yes/No	Boolean
Autonumber	Serial / Bigserial

Table 1: Data types in MS Access and PostgreSQL

Once the data structure was created, the tables were linked to the MS Access application. Then, data from the MS Access tables was copied into the linked PostgreSQL tables through append queries. After appending the data, the MS Access tables were deleted from the application. Apart from setting the connection parameters, only a few modifications were needed to make the application work with the PostgreSQL database. The result is a database system that still uses the familiar MS Access interface, but with a more reliable database back-end that can store millions of land records. Re-training of database users will not be needed, since the interface still looks the same and none of the database functions have changed.

2.4 GIS tools for PostgreSQL

Since the start of the LMAP project, a number of GIS tools have been developed to facilitate the land registration work. The tools work with ArcGIS and are used for digitizing of land parcels, updating area information in the database and for printing Land Titles. Before the PostgreSQL database with MS Access interface can be deployed in the provincial offices to be used for land registration activities, these GIS tools had to be modified to be able to connect to the PostgreSQL back-end database through ODBC. The printing of Cambodian Land Titles is fully automated; and printing hundreds of land titles for the same village is a

matter of minutes. As shown below, the Land Title includes a map of the land parcel as well as ownership information. The parcel map comes from an ArcGIS map document; while the ownership information is pulled from the MS Access attribute database.

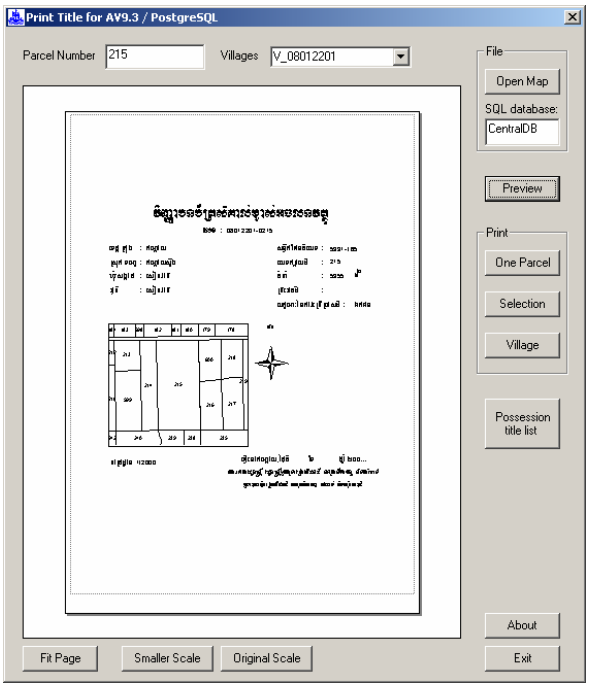

Fig. 1: Printing Land Title Certificates

Now, this title printing application (as well as other GIS tools) has been modified to work with PostgreSQL back-end databases. Here, the advantage of using PostgreSQL compared to MS Access is that more users can simultaneously access and edit the database without problems.

2.5 Open source GIS software

Now, all is ready to migrate the MS Access back-end databases to PostgreSQL, use ArcGIS to digitize and maintain the cadastral boundaries, and print Land Titles through the ArcGIS/PostgreSQL connection. For LMAP, this combination of low-cost proprietary and open source software will work for the next few years. However, when multi-user editing of GIS data is needed or when map data must be shared over the internet, more than ArcGIS is needed. Should LMAP invest in the costly ArcServer licenses or find open source alternatives instead?

Open source GIS software has really taken off in the last few years. To name a few, uDIG, Quantum GIS and gvSIG are recent open source desktop GIS products that could be used instead of ESRI ArcGIS. When LMAP started in 2002, these products had not been developed yet, and open source GIS was not really an option. So far, the LMAP project has made use of

ArcGIS software with success. The costs of ArcView/ArcGIS are relatively low compared to other commercial GIS software, and it offers good value. It is hard to find other GIS software with as many vector editing capabilities as ArcGIS. The ArcObjects development kit that comes with the software makes it relatively easy to customize ArcGIS for almost any GIS requirement. Yet, there are a few limitations compared to the open source desktop GIS solutions that are currently available. For topology validation and editing, the ArcView version offers too few possibilities and the more expensive ArcEditor licenses must be purchased. With ArcGIS software, users can connect to PostgreSQL databases through an ODBC connection. But connecting directly to a server-based database to edit and digitize GIS data that is stored there is not possible unless the ArcServer license is bought in addition to ArcGIS. In the world of open source GIS software, the editing of PostGIS tables stored in PostgreSQL directly from the desktop application is almost a standard feature. With uDIG, gvSIG and Quantum GIS, users can directly create and maintain geographic datasets stored in PostgreSQL.

Apart from topology functions and direct PostgreSQL connection, a switch to open source GIS software would greatly facilitate software maintenance and upgrading. LMAP currently has three different versions of ArcView licenses spread over the 15 provincial offices, since the older licenses are not upgraded when new licenses are bought. The GIS tools that were created for LMAP have to be maintained for all the ArcView versions that are being used. Software upgrading, as well as hardware upgrading, can be a long procedure in Cambodia. It took eight months to get the upgrade packages for ArcGIS 9.0 out of the customs facility at the airport, as a result of bureaucratic procedures. With open source GIS software, upgrades can be downloaded and installed immediately.

The switch from ArcGIS to open source GIS seems inevitable, but until now, no cadastral tools have been developed that would allow LMAP to print Land Title Certificates and to handle parcel subdivisions and consolidations using an open source GIS product.

3. CURRENT USE OF OPEN SOURCE SOFTWARE

3.1 National Land Registration Database

So far, not much of the open source plans have been implemented in LMAP. The installation of PostgreSQL in provincial cadastral offices and migration of all land registration databases from MS Access to PostgreSQL has been postponed until the arrival of new computers and network servers. The migration from ESRI ArcGIS to open source GIS software must wait until cadastral tools for an open source desktop GIS have been developed. But there is one area where the use of open source software in LMAP is already successful.

The Cambodian Land Register exists as separate provincial databases, which are updated in provincial cadastral offices. Backups of these MS Access databases are sent regularly to the central cadastre in Phnom Penh. Using these backups, the data from 15 provinces has been combined into a national land register database in PostgreSQL. With over 1.5 million land records, the data could never have been stored in an MS Access database. The national land

registration database is used to monitor the registration progress in the provinces, extract information on land transactions, and for statistical purposes. Whenever new provincial backups are available, the national database is updated. As a central data store, this national land registration database forms a good basis for the development of a Land Information System with public information services over the internet.

3.2 Advantages

The use of PostgreSQL database software for the Cambodian land registration system brings considerable advantages. More users can simultaneously access the database; the amount of data that can be stored is virtually unlimited. The data storage and processing becomes more reliable and more secure. Still, all those advantages would have been obtained as well with proprietary database software such as Oracle or SQL Server. What is then the advantage of using PostgreSQL database software for LMAP? The availability of the source code will be of little use, as there are no plans to modify the database software for use in LMAP Cambodia. The fact that PostgreSQL is free of charge is certainly an asset, but money is not really the problem. The real advantage here is that by choosing for open source, freely available software is that the installation, migration and upgrading can be managed without unnecessary procurement hassles and delays.

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BIOGRAPHICAL NOTES

Gertrude Pieper Espada obtained her degree in Human Geography from the University of Utrecht in 1994. She has worked as a GIS consultant with IT companies in Germany, Portugal and Finland. She has also worked with F.A.O. in Honduras and in Rome. In March 2002 she started to work with FM-International Oy FINNMAP, and in October 2002 she joined the Finnish Technical Assistance Team as IT advisor for the Ministry of Land Management, Urban Planning and Construction in Cambodia.

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