

# Designing a low-cost WebGIS system for delivering land information via internet

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**Abstract.** One of the biggest problems of Vietnam's property market is its low level of transparency. An indication of this problem is that people usually are unable to obtain land information as they need due to both technical and organisational limitations. To partially resolve this problem, the authors have proposed a technical solution by designing a simple, low-cost system based on open source WebGIS technology for delivering land information to people anywhere and anytime. The system was tested for Nguyen Du Ward (Hai Ba Trung District, Hanoi City) and Phu Khe Commune (Tu Son Town, Bac Ninh Province), and initially got positive results.

**Keywords:** Internet; WebGIS; Land information; Open source software.

## 1. Introduction

Vietnam's property market is a relatively young market and thus has many problems to be resolved. Among those the most prominent is the transparency of the market. According to qualification table published by Jones Lang LaSalle - the world leading company in the field of real estate services - Vietnam's property market is still in the lastest group having a very low transparency index (56/56 in 2006 and 77/82 in 2008 year) [4]. One of the reasons is that most of land information in Vietnam usually are unavailable to people. The problem has three aspects: organisational, social, and technical. This paper will deal with the last, technical, aspect.

In recent years, internet has become the dominated infrastructure for delivering

information to people. Using the internet infrastructure, the WebGIS technology quickly gain its popularity thank to the capability to deliver both spatial and attributive data. Thus, WebGIS is used in most of the land information delivery services.

The Dutch Kadaster-on-line system was established in 2001 with the aim of making land information of The Netherlands available for everyone [10]. Via screens displayed in a standard web browser, Kadaster-on-line allows clients to make a selection of the cadastral registration and then delivers the requested information in the form of HTML, XML or PDF messages in the browser or PDF messages via e-mail.

Extending the idea of Kadaster-on-line, in 2006, a new project called European Land Information Service (EULIS) was started by a consortium of eight organisations which are responsible for land and property information in European countries [6]. The technical

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infrastructure of EULIS facilitates the goal of giving users seamless access to land register information across borders, if they have the right agreement with their local land register for online access. The EULIS portal is the central hub in the EULIS infrastructure; the other servers will normally act as a supplier or distributor, depending on which way the traffic flow is with the current user. By implementing a set of web-services on the EULIS portal, and making some adaptations on the other servers in the EULIS network, it is possible to implement this without having to replicate user information between all the servers.

Along with European initiatives, many countries have adopted WebGIS technology for supplying land information to the users in a convenient way. Examples are Jamaica [7], Mongolia and India [5], Australia [1], Singapore and Canada [11], etc.

In Vietnam, only a few efforts were made in using WebGIS for land or land-related data distribution. Some WebGIS systems have been developed by local or central governmental organisations, but these systems either are in their testing stage or have poor support. Examples of such systems are the website of Bac Ninh Province publishing cadastral data (<http://sotnmt.bacninh.gov.vn>, under reconstruction since 2007), or the GIS site of the Vietnamese Government (<http://gis.chinhphu.gov.vn>, currently does not work).

The Information and Communication Department of Ministry of Natural Resource and Environment experimentally created a WebGIS system (following OpenGIS Web Map Service specification) for publishing topographic and cadastral maps of some regions on internet at address <http://ciren.vn>. However, the information content still is poor, and cadastral maps only periodically are accessible, if any.

Recently, the Ho Chi Minh City's government has financed two researches on application of

WebGIS technology: "Research on creation of integrated GIS data model for HCM City's GIS", and "Research on creation of a WebGIS system for administrative boundary management" [2]. These researches have achieved some positive results. However, really working WebGIS systems still are hardly recognised.

Our review shows that currently most of the WebGIS systems in Vietnam are in the developing stage, and many of them are based on commercial development platforms. Thus, they are relatively expensive while currently have a very limited usability. This research is an effort of the authors to partially resolve these problems.

## 2. System design

### 2.1. Development platform selection: open-source vs. commercial data management software

There are two types of the development platforms for land data distribution systems on internet: the open source development platforms, and the commercial ones. The former has an advantage of low starting cost and the transparency of the system, while the latter is featured advanced functionalities, better scalability, and easier development of large systems [8]. The more detailed comparison based on our experiences is presented in Table 1. From the comparison, it is clear that the open source platform is the most suitable for a low-cost and simple WebGIS system.

Among available open source platforms, the pair of UMN MapServer (MS4W) - CartoWeb is chosen in this research due to their better scalability and availability of development support tools. Moreover, MapServer has always been on the forefront of WebGIS technology, offering some features that are not available even in many commercial solutions. The development of MapServer is driven by highly motivated open source software developers and guided by highly demanding users [9].

Table 1. Comparison of open source and commercial platforms for WebGIS system development

	Open source development platforms	Commercial development platforms
Advantages	<ul style="list-style-type: none"> <li>- Low cost</li> <li>- Transparency of the system</li> <li>- Possibilities of low-level tuning for advanced developers</li> </ul>	<ul style="list-style-type: none"> <li>- Better availability of tools supporting development</li> <li>- Usually good scalability</li> <li>- Good support</li> <li>- Advanced functionalities</li> <li>- Better processing speed and capabilities</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>- Limited functionalities</li> <li>- Development of a large system is complicated</li> <li>- Limited scalability</li> </ul>	<ul style="list-style-type: none"> <li>- High cost</li> <li>- Dependency on software developers</li> </ul>
Examples	MapServer (MS4W) CartoWeb GeoServer TatukGIS	ArcGIS Server ArcIMS MapXtreme MapGuide Geomedia WebMap

2.2. System architecture

The system architecture is presented in Fig. 1. When an user makes a request to the server via internet, the internet server (in this case - Apache) process the request. There are two scenarios:

- If the request requires only textual data then the internet server will process it and return data to the user (via internet)
- If part(s) of the request requires spatial data (maps), it will be addressed to CartoWeb, and then, after preliminary processing, to MS4W. MS4W will process the request, making access to geodatabase, and then return data to the user via Apache.

2.3. Database design

For achieving an effective database design, it should be defined what kind of information will be delivered via internet. Here, there main factors can be considered:

- The main content of information required by the users of the system.
- The easiness of data maintenance and update.
- The data security.

Considering the primary aim of building a low-cost and easy-to-maintain system, we proposed to use data layers listed in Table 2.

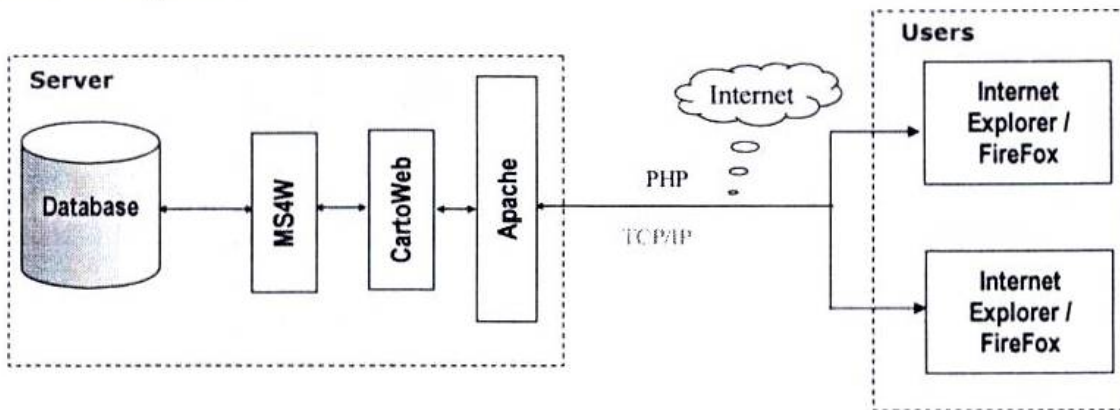


Fig. 1. The system architecture.

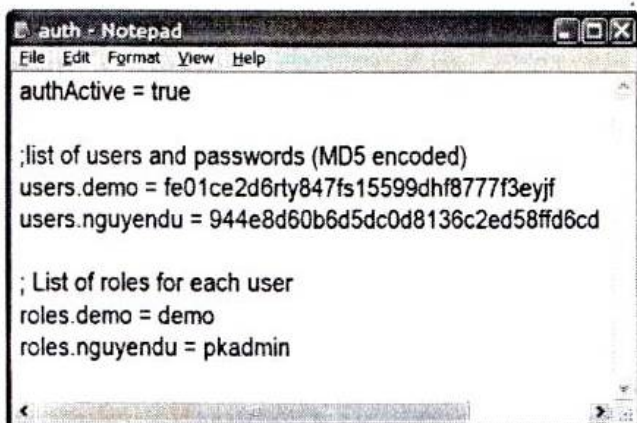
Table 2. The data layers

Layer	Description	Spatial type	Main attributive fields
AdminUnit	Administrative units (ward, commune)	Polygon	Name, Area, District name
FeaturedObjects	Cultural and socio-economic objects	Point	Name, Description
Roads	Transportation roads (as lines only)	Line	Name, Road class, Width
Parcel	Land parcel	Polygon	Number, Area, Owner, Land use code, Price (defined by the government)
House	Houses	Polygon	Type, Number of floors, Area, Year of building
MarketLandValue	Market land value zones	Polygon	Estimated market value
LandUsePlan	Land use plan	Polygon	Land use code, Description
LUPSchedule	Current schedule of the land use plan	Polygon	Implementation information, Land recovery (LC) information, LC schedule, LC difficulties

The database is designed as shapefiles - the primary format that is supported by MS4W, CartoWeb and most of other open source WebGIS systems.

#### 2.4. User right management

In the system design, not everyone can have access to all land data distributed on internet. Some sensitive or closed data are available only for a limited number of users which have enough privileges. This can be done using the authentication system supported by MS4W and CartoWeb.



```

authActive = true

;list of users and passwords (MD5 encoded)
users.demo = fe01ce2d6rty847fs15599dhf8777f3eyjf
users.nguyendu = 944e8d60b6d5dc0d8136c2ed58ffd6cd

; List of roles for each user
roles.demo = demo
roles.nguyendu = pkadmin

```

Fig. 2. User account management in CartoWeb.

There are two user groups in the system:

- Anonymous users: do not need to log-in. However, these users do not have access to LUPSchedule layer.

- Registered users: need to log-in and can have access to all data layers.

Each registered user has an account consisting of user name and password. User accounts are managed in the Auth.ini file of CartoWeb (Fig. 2). Due to the security reason, the passwords are encoded as MD5 sums [3].

#### 2.5. Vietnamese font encoding

Since the system is intended to use in Vietnam, a Vietnamese user interface is mandatory. However, there is an issue in the selection of Vietnamese font encoding table:

- Two encoding systems supporting Vietnamese fonts are available today: the first one is 1-byte system, including TCVN-ABC, VNI encoding tables; and the second one is 2-byte system, including various unicode encoding tables.

- The shapefile data format used by MS4W and CartoWeb only supports 1-byte encoding table. While the most popular web browsers (Internet Explorer, FireFox, Opera) only fully

support 2-byte encoding. These browsers can display text in 1-byte encoding, however, some characters, such as "r", are displayed incorrectly.

Our solution is to use the unicode UTF-8 Literal encoding table. It drops 2-byte unicode characters into a sequence of two 1-byte characters. For example:

Ä át Ä ai = Đất đai

Thus, UTF-8 Literal is supported by both shapfile format and web browsers.

The drawback of UTF-8 Literal is that the text is 2 times longer than usual and it is difficult to read directly in database. However, since only system administrators are supposed to maintain the database, it can not become a big problem.

### 2.6. Low-cost server infrastructure

For lowering the demand on computing power of the server, the database is proposed to be separated by administrative units (wards or communes). This solution makes the design process a bit more complex, but the system can be installed on a low-end server computer.

Another aspect can be considered is the cost of the internet line. Usually, the server computer is connected to internet using a static IP (Internet Protocol) address. However, the internet access packages with static IP address is more expensive than the ones with dynamic IP address. Our experiment shows that dynamic IP address can be used for installing the system. We do the following:

- Register an account at [www.no-ip.com](http://www.no-ip.com) and create a host name, e.g. [hus-lis.no-ip.org](http://hus-lis.no-ip.org).
- Use the "Port Forwarding" function of the ADSL modem to redirect the *www* service to the port #80.

## 3. Test results and discussion

### 3.1. The test areas

The system is tested in two administrative units: Nguyen Du Ward (Hai Ba Trung District, Hanoi City), and Phu Khe Commune (Tu Son Town, Bac Ninh Province).

- Nguyen Du Ward is a typical urban administrative unit, being located in the centre of Hanoi City. The ward is featured a very high market value of land (as high as 250 mil. VND / m<sup>2</sup>). The following data were collected for the ward: cadastral maps (at 1:200 scale) with corresponding land registry data, a land value map (at 1:1000 scale), and topographic maps (at 1:2000 scale).

- Phu Khe Commune is a rural administrative unit located in about 20km north-east from centre of Hanoi City. Recently, the commune became an peri-urban area since the former Tu Son District changed its status to a provincial town. The data collected in Phu Khe Commune include: cadastral maps (at 1:1000 scale) with corresponding land registry data, topographic map (at 1:10.000 scale), high-resolution satellite imagery, land use planning map for the period 2006 - 2015 with attributive data, and information supplied by the local government about land use planning schedule.

### 3.2. Results and discussion

For accessing the system, one can use any web browser (Internet Explorer, FireFox, Opera, etc.) in a computer having internet connection. Going to the address <http://hus-lis.no-ip.org> (temporary internet address for this test), the user will be asked to select an administrative unit for viewing data. After that, the map of the selected administrative unit will be displayed in the browser (Fig. 3 and 4).

The user can do the following actions:

- Choose map layer(s) to be displayed in the table of contents.
- Zoom, pan, and change the size of the map frame.
- Zoom to predefined areas.
- Display background imagery.
- Measure distance and area on the map.
- Query attributive data of the interested object on the map.

As an anonymous (unregistered) user, the user only has access to a limited layers of the map, such as parcels, houses, topography, land use planning, market land value, etc. If the user registered and logged on, he (or she) can have

access to other layer(s) of the map (land use plan schedule in this experiment).


Fig. 3 is an example of querying data on the map of Nguyen Du Ward by an anonymous user. By activating the info mode  and clicking on the interested parcel, the attributive data of the parcel will be displayed as tables below the map.

Fig. 4 is an example of what can do a registered user on the map of Phu Khe Commune. After logging on, the use will be able to query data about schedule of the land use plan: timeline of each land use planning object, the status of the object, existing problems in site clearance, etc.

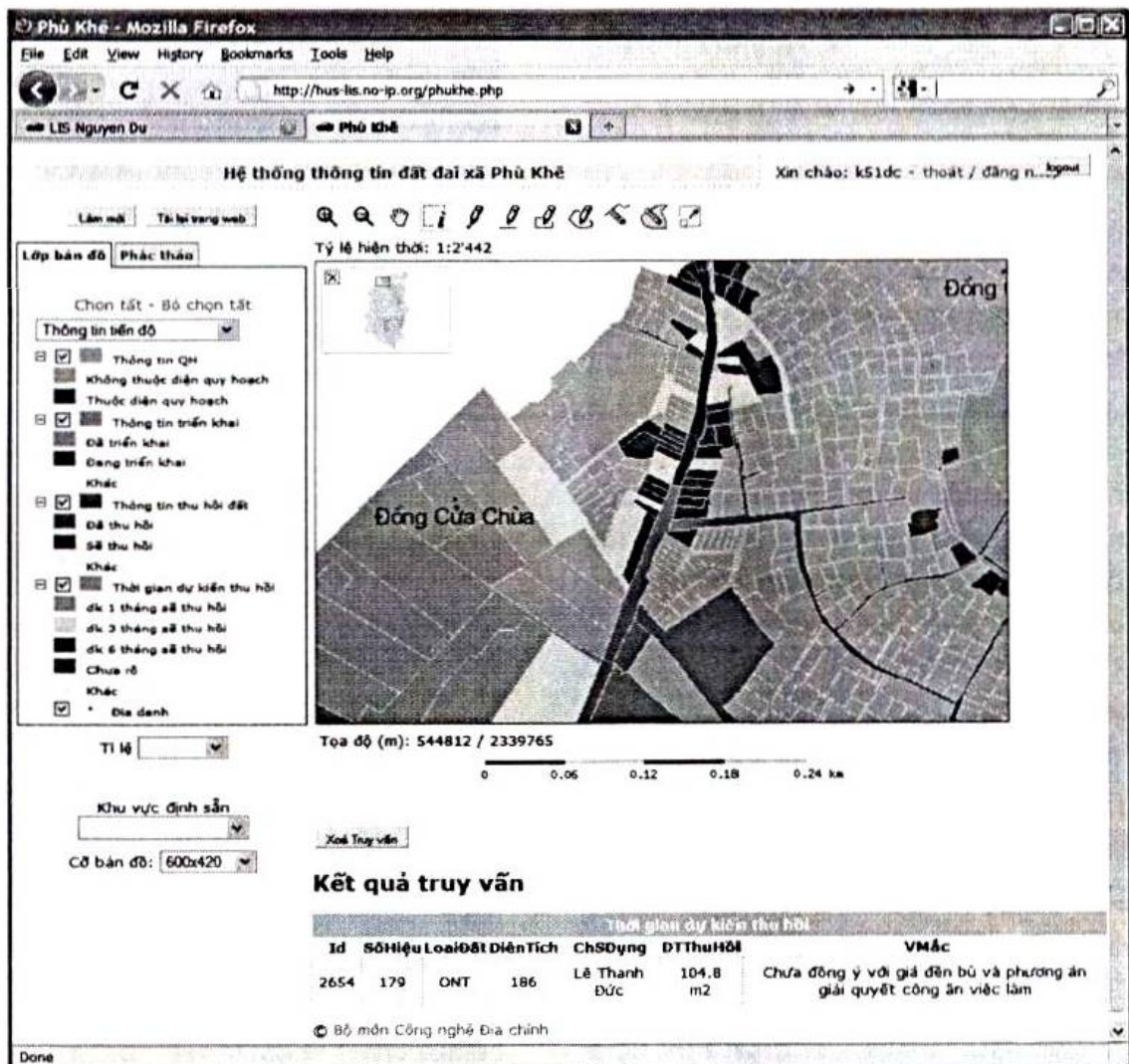


Fig. 3. Land information system of Nguyen Du Ward.

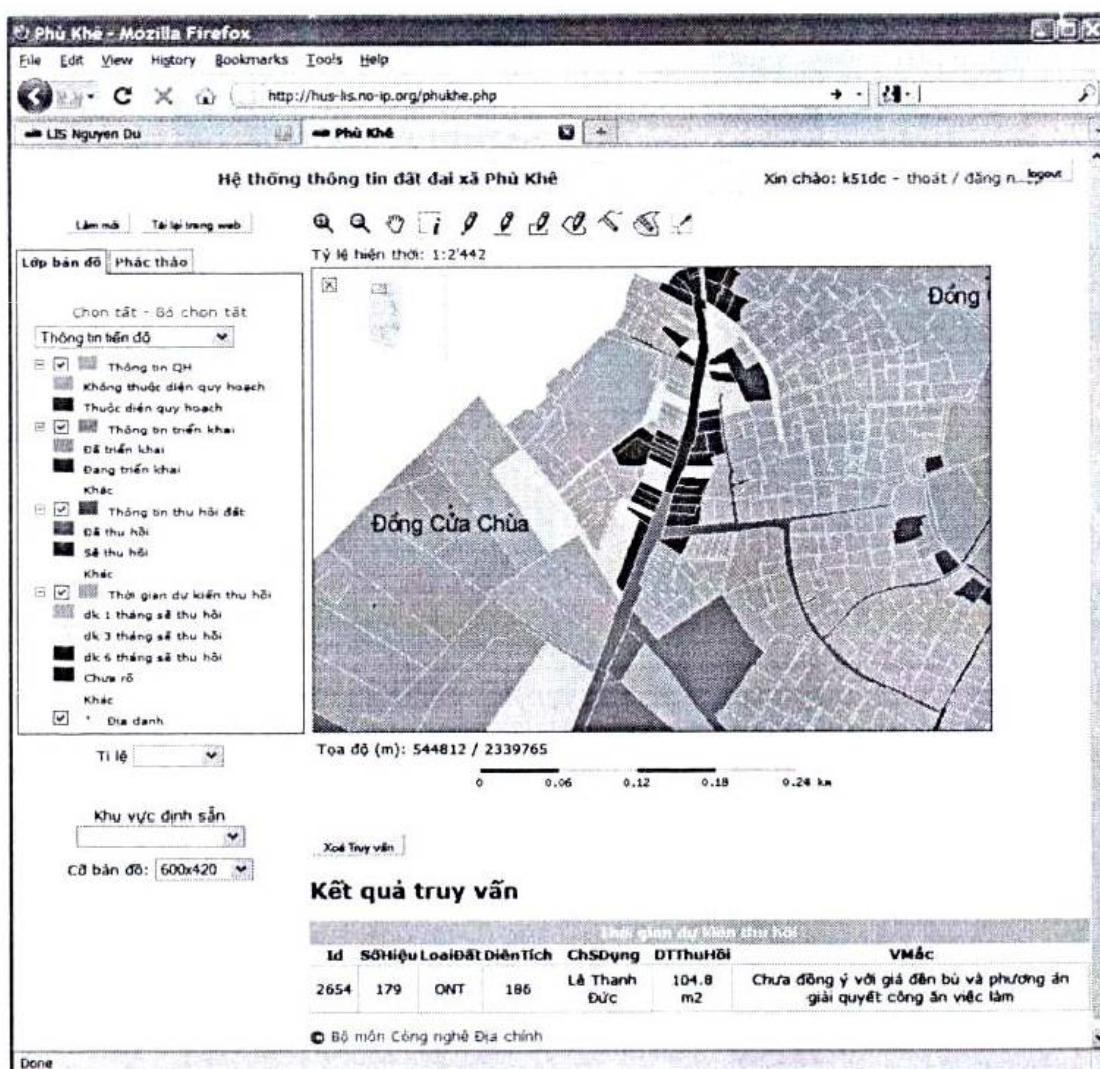


Fig. 4. Obtaining information on land use planning schedule of Phu Khe Commune.

To evaluate how easy the system can be learned, we made an experiment with eight undergraduate students. At first, the instructor made a short introduction about the system for five minutes and then asked them to use the system. Three students passed this test, the rest five students have another five minutes of learning and they all passed the test. Thus, the time required for learning the system is estimated of about seven-eight minutes.

Another experiment was carried out to estimate the response time of the system. The above mentioned students are asked to simultaneously open the map, zoom in, query attributive data, and measure the total time of these operations. Using a system installed on a

local server with Core 2 Duo E6500 CPU, 1GB RAM, and single SATA hard drive, we obtained the following averaged time:

- 1 user: 17 seconds;
- 2 users: 19 seconds;
- 4 users: 24 seconds;
- 8 users: 38 seconds.

Thus, a low-end server with moderate speed of internet line can serve a group of 20-30 users. Here, we take into account that the users will actually query data in ~20-30% of the time they use the system.

The biggest problem encountered in our experiments is the data availability. Either the data simply are not existed, or the local

governments are not willing to supply them. Therefore, the developed system will be success only if the government takes effective organisational measures for ensuring data supply to the system.

#### 4. Conclusions

Today, internet is the most effective network infrastructure for delivering information to people, and WebGIS is the key technology for handling and distributing spatial information via internet.

The authors have designed a simple, low-cost WebGIS system based on an open source development platform for delivering land information to people anywhere and anytime. The system was tested for Nguyen Du Ward (Hai Ba Trung District, Hanoi City) and Phu Khe Commune (Tu Son Town, Bac Ninh Province), and initially got positive results.

It must be noted that a single technical solution is not enough to effectively deliver land information to people. For the success, the government's organisational measures for ensuring data supply are strongly required.

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