# BUILDING LOOKUP MAP FOR LAND PRICE BY QUANTUM GIS (QGIS): AN APPLICATION OF OPEN-SOURCE DESKTOP GIS IN LAND MANAGEMENT

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## ABSTRACT

*Today, building map has become simpler because of the support of powerful spatial software such as ArcGIS, AutoCAD, MapInfo, ... Most of them are commercial software and any form of copying and use free is considered illegal. It is difficult to maintain and upgrade the system for land management offices in large-scale after purchasing license due to the high cost. Therefore, the open source software is now considered as reasonable solution to resolve these problems. The objectives of study are: (1) build and develop process in applying open source (QGIS) for mapping land price lookup; (2) assess the strengths and weaknesses of applied open source in land management; (3) propose solutions in exploiting land price map on information systems to serve the management of urban land. The results showed that the unit cost of land at An Cuu Ward was determined as six areas according to classified streets. From database, there are 9% plots in position 1, 18% plots in position 2, 15% plots in position 3, and 58% plots in position 4. Regarding the direction of land parcels, it shows that 61% plots are in good direction and 39% plots are in worse direction. Of the total, number of plots with good form is 8%, and bad form is 92%. Scale factor values are divided into 3 size, standard (70 - 150m$^2$), over standard (>150m$^2$), and under standard (<70m$^2$). Based on attribute tables, there are 38% plots in standard size, 40% plots over standard size, and 22% plots under standard size. From results above, the price of each land parcel is calculated by using expression function in QGIS and showed in map. Detailed information of each parcel can be quickly and accurately looked up by functions in QGIS. Consequently, it helps land management carried out quickly, timely and effective.*

## 1.    INTRODUCTION

Land is a precious resource of each country, the condition for the existence and development of human beings and other creatures on earth, and the major means of production (Ho Lam Tra, 20050. In addition, its inherent characteristics such as fixed position, limited in quantity and space, and infinite time has made land becoming scarce and more valuable, in particular urban land (Nguyen Thanh Tra, 2004). Therefore, it is necessary to have a serviceable tool for managing the real estate market, especially the land price. Geographic Information System (GIS) - an effective tool for managing natural resources, is quite common application in establishing thematic maps. In frame of nation, the application of GIS in professional land management contributes to improving the efficiency of management as well as the exploitation of land resources in serving the development process (Tran Van Huong, 2012) .

Currently, building map has become simpler because of the support of powerful spatial software such as ArcGIS, AutoCAD, MapInfo, ... However, most of them are commercial software and any form of copying or use free is considered illegal. It is difficult to maintain and upgrade the system for land management offices in large-scale after purchasing license due to the high cost. Therefore, the open source software is now considered as reasonable solution to resolve these problems (Tran Quoc Binh, 2010; Trinh Van Tan, 2012), especially after the approval of series of Vietnamese policy related using open source software, such as Decision No. 235/2004/QD-TTg in March 2, 2004 of the Prime Minister about approving the

overall project in application and development of open resource software in period of 2004-2008, Circular No. 41/2009/TT-BTTTT in December 30, 2009 of the Prime Minister about issued catalog of open source software products as requirements for use in offices, state organizations. Realizing the necessary in applying open source software on land management, this study was conducted to build lookup map for land price at An Cuu Ward, Hue City, Thua Hue as case study, which use information technology to manage land price quickly, promptly and effectively. The objectives of study are: (1) build and develop process in applying open source (QGIS) for mapping land price lookup map; (2) assess the strengths and weaknesses of applied open source in land management; (3) propose solutions in exploiting land price map on information systems to serve the management of urban land.

## 2. STUDY AREA

The study was taken place at An Cuu Ward, located in the southwestern gateway of Hue city, with favorable conditions for transportation, as well as economic-societies exchanges. Therefore, the frequency and the price of land use right in transfer are rather high in comparing with other neighboring wards.
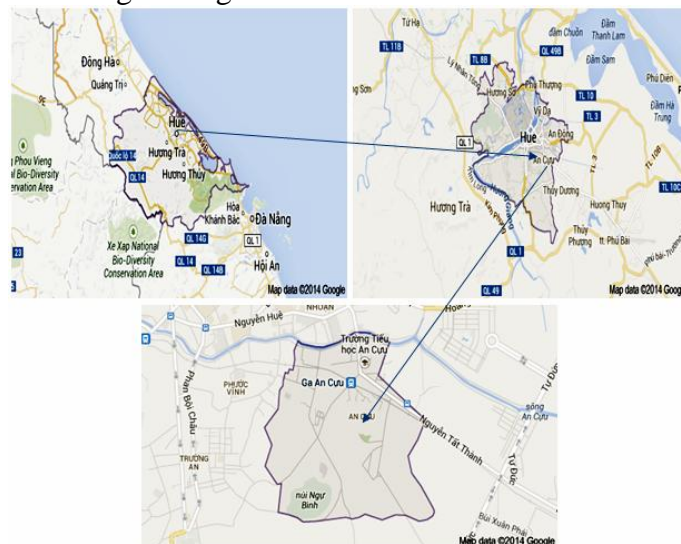


**Figure 1. Location of An Cuu Ward**

## 3. MATERIALS AND METHODOLOGIES

### 3.1 Materials

In this study, all transaction information on the real estate market at An Cuu Ward were collected in years of 2011, 2012, 2013 from the different sources. Because of the time condition and detailed requirements for each land parcel, information systems of land prices in An Cuu Ward were built just only for cadastral map No.12 in total of 63 cadastral maps. The spatial information were converted into *.shp and then imported to QGIS. Attribute information of land parcel were created by QGIS regarding influencing factors of location, direction, scale, and form of land parcel. Consequently, the price of land in An Cuu ward is calculated based on unit cost of land, land area and the influencing factors.

### 3.2 Research methodologies

- Gathering data: natural conditions, economic-social data, the current state of local

land use, transferring of land use right at An Cuu ward, legal documents related to the land price from the annual report (2011-2013) were collected from statistical yearbooks, and other documents. Land price were collected by interview through 51 conducted households, individuals and organizations whose parcel of land was transferred successfully in the transfer contract from 2011 to 2013 in major streets at An Cuu Ward.

- Method of comparing market data is used to determine the price of land at market prices.

- Method of mapping is used to construct the attribute information of map layer, spatial partitioning of land prices in the open source software QGIS.

## 4. RESULTS AND DISCUSSIONS

### 4.1 Determining land price by the method of comparison market data

During the period of three years from 2011 to 2013, the numbers of transferred parcels in An Cuu Ward are high. However, most of the transaction happened only in some main roads that have good condition of infrastructure. After collecting the contracts, all invalid cases were removed; only the transferred contracts with the actual price in the real market were collected. By which, the factors that affect the price of land (location, area, shape, size, direction of parcel ...) were identified through investigated plots. Each factor has its own effect on price of land in An Cuu Ward (Nguyen Van Suu, 2012). Other factors such as the policy, land use planning, flood, public security, etc…are particular factors and do not consider in term of this study.

The results showed that the unit cost of land at An Cuu Ward were determined as six areas according to classified streets, including: area 1 - 32.000.000VND/m$^2$, area 2 - 25.000.000VND/m$^2$, area 3 - 22.000.000VND/m$^2$, area 4 - 18.000.000VND/m$^2$, area 5 - 12.000.000VND/m$^2$, area 6 - 8.000.000VND/m$^2$. As stated above, land price at An Cuu Ward were determined by method of comparing market data, which focused on the effects of factors. It indicates that there four factors that influenced the increase of land price including location, direction, size and shape of the parcel at different degree of coefficient (Table 1). According to analytical result, there are 9% plots in position 1, 18% plots in position 2, 15% plots in position 3, and 58% plots in position 4. Regarding the direction of land parcels, the factor gets two values: good direction and worse direction. It shows that there are 61% plots in good direction and 39% plots in worse direction. Similarly, form of land parcel is divided as good form and bad form. Of the total, number of plots with good form is 8%, and bad form is 92%. Scale factor values are divided into 3 size, standard (70 - 150m$^2$), over standard (> 150m$^2$), and under standard (<70m$^2$). Based on attribute tables, there are 38% plots in standard size, 40% plots over standard size, and 22% plots under standard size.

**Table 1. Coefficients of affecting factors to land price at An Cuu Ward**

| Area code | Standard price (million VND/m$^2$) | Influenced factors | | | | | | | |
| | | $K_{Location}$ | | | | $K_{Shape}$ | $K_{Direction}$ | $K_{Size}$ | |
| | | $K_{L1}$ | $K_{L2}$ | $K_{L3}$ | $K_{L4}$ | | | > Standard | < Standard |
| 1 | 32 | 0,954 | 0,665 | 0,526 | 0,395 | 0,932 | 0,808 | 0,900 | 0,83 |
| 2 | 25 | 0,954 | 0,665 | 0,526 | 0,395 | 0,932 | 0,808 | 0,900 | 0,83 |
| 3 | 22 | 0,954 | 0,665 | 0,526 | 0,395 | 0,932 | 0,808 | 0,900 | 0,83 |
| 4 | 18 | 0,954 | 0,665 | 0,526 | 0,395 | 0,932 | 0,808 | 0,900 | 0,83 |
| 5 | 12 | 0,954 | 0,665 | 0,526 | 0,395 | 0,932 | 0,808 | 0,900 | 0,83 |
| 6 | 8 | 0,954 | 0,665 | 0,526 | 0,395 | 0,932 | 0,808 | 0,900 | 0,83 |

## 4.2    Building database for land price map by QGIS

As GIS software, QGIS is capable of creating and updating spatial database like other commercial software. In this study, digital cadastral maps were utilized as input for spatial database. Because of cost in time and labor during process of building database for land price map, only cadastral map No.12 of An Cuu Ward was chosen. To import spatial database to QGIS, several steps must be done to prepare standard format for this software. Firstly, map data collected in the form of files (*.dgn) of Microstation software are needed to switch to format of shapefiles (*.shp). All properties of the objects on the cadastral map must be kept. Secondly, because QGIS has not supported the datum VN2000 yet, converted map in form of shapefiles (*.shp) must be changed to datum WGS84-48N.
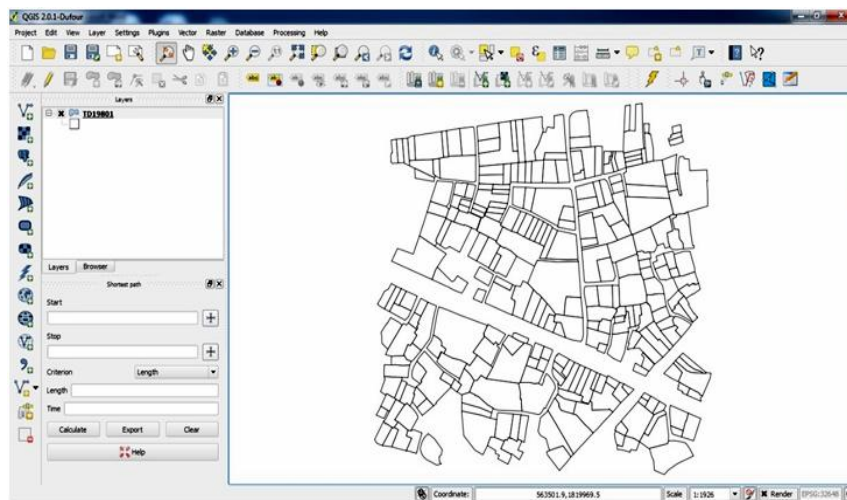


**Figure 2. Cadastral map No.12 on QGIS**

From results above, the attribute data of factors that affect price of each parcel was constructed. These thematic maps provide not only common information of parcel but also details of influenced factors (Figure 3).
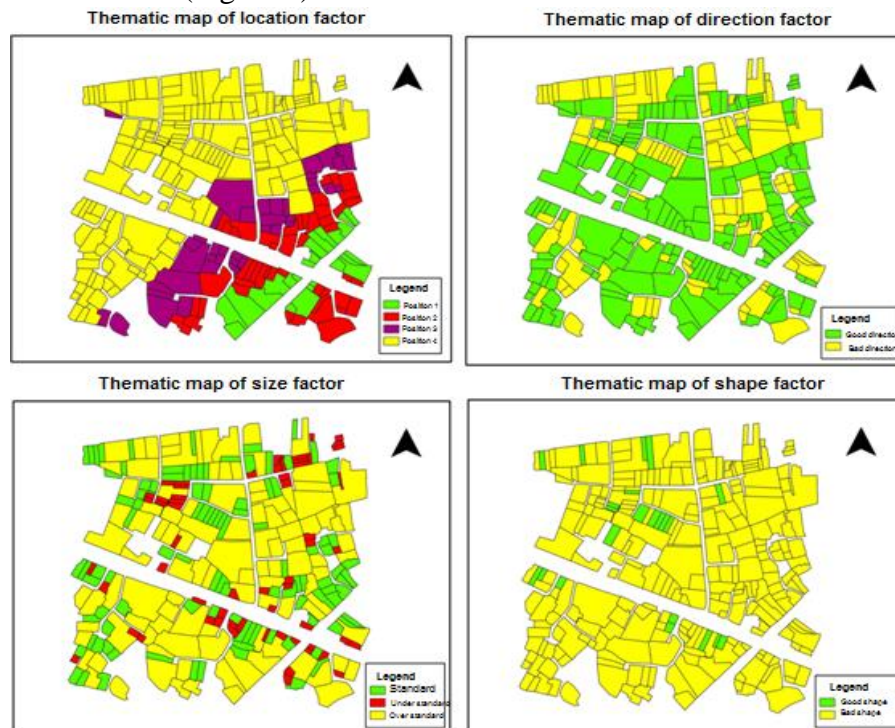


**Figure 3. Thematic maps of influenced factors**

All thematic maps were thereafter overlaid to get land price map (Figure 4). In which, price of parcel was calculated from unit cost of one parcel and coefficient of each factor. This lookup map will provide essential data for estate management, such as information on the number of parcel, purpose of land use, acreage, soil type, land owner, the factors affecting land price, market price, the name of street, etc… These detailed information of each parcel can be quickly and accurately looked up by using Query function, Advance Filter (Expression), or Select function in QGIS. Consequently, it helps land management carried out quickly, timely and effective.
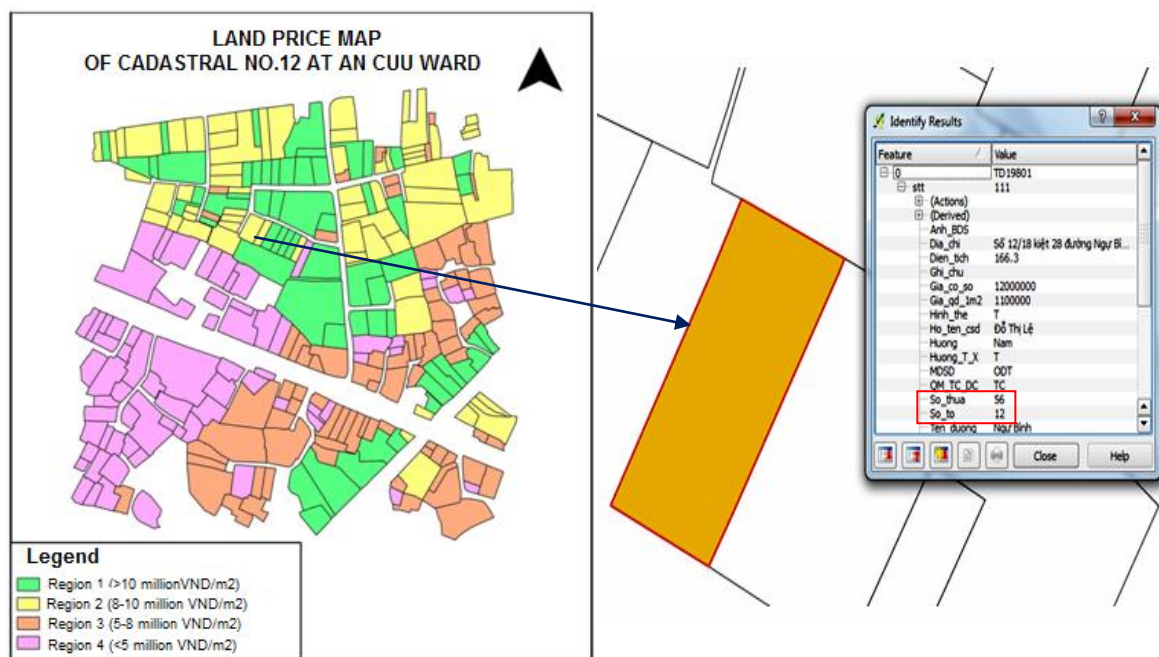


**Figure 4. a) Land price map of cadastral No.12 at An Cuu Ward; b) Detailed information of parcel No.56**

### 4.3 Assessing strengths and weaknesses of QGIS software and the ability to apply in practice

Through the research, we found that QGIS has some advantages in building database for land management:
- QGIS can work with multiple operating system: Microsoft, Mac OS, Linux, UNIX;
- QGIS allows to query, display data and overlay maps;
- QGIS supports many formats and projection:
    + Vector: ESRI Shapefiles, MapInfo files, Microstation DGN, AutoCAD DXF, ...;
    + Raster: ERDAS Compressed Wavelets, Geo TIFF, ...;
- QGIS has ability to switch data formats, to analyze easily, and export the map as an image (such as jpg, jpeg, png, bmp,…), or pdf files;
- QGIS has most of GIS basic function, friendly interface and many other features in QGIS can be done via extensions (plug-ins);
- The users can use QGIS without paying royalties and create themselves additional tool to support their work.

Besides, QGIS also has some drawbacks:
- Lacking of tutorial documents;
- QGIS can work only with shape format (*.shp);
- The interface of QGIS is not stable and changes over versions;

- The ability of QGIS in map editor, map presentation is still limited;
- QGIS requires the users to have certain qualifications as other software;

As can be seen, QGIS is capable in creating map for land management, especially lookup map of land price. To widely disseminate and maintain the result of study, it should continue to build the database of land price for remaining cadastral maps of An Cuu Ward. In addition, a standard format should be prepared to sync and consist data received from other software for less time-consuming in converting data process. It is also needed to improve informatics skill for the staffs to solve difficult tasks in land management.

## 5.    CONCLUSIONS

Open source GIS software in general and QGIS in particular bring great opportunity in creating thematic maps. QGIS also gives a vision, an overall assessment about spatial of managed objects by multiple data sources for managers. As can be seen, the application of QGIS in mapping land prices is workable because of its convenient in building geo-database, and the capability to make the query easily and accurately.

Through the research process, it is found that the information of land price of each parcel at An Cuu Ward is provided quickly, completely and accurately by QGIS. To disseminate the result of study, information system on land prices at An Cuu Ward should be continue to implement for the remains of cadastral maps. To maintain the application of QGIS, it is needed to invest equipment for the staffs of An Cuu Ward, improve the application of QGIS in solving land management tasks. Besides the capability of providing market price of land, the information system built on software QGIS also gives detailed information on a parcel, which supports the local authorities in land management. QGIS is open source software that is free of charge. Consequently, the users do not have to worry about copyright issues and funds for the maintenance of the software.

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