



## REIS: A spatial decision system for land valuation

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(Received: Mar 01, 2016; in final form: April 13, 2016)

**Abstract:** Land is a vital asset for any federal government. Valuation of land is a very important activity as it has high impact on revenue generation for any country. Present valuation technique is time consuming and cannot quantify the spatial importance of the land for decision making related to real estate. GIS provides a technical platform for management of geographic data and inherent location information to support application of spatial statistical and location econometric tools. Spatial database helps to take decisions for their projects and act as a base data for further functions like tax calculation, land purchase etc. The main objective of this study is to develop a Real Estate Information System (REIS) for the valuation purpose especially for the buying, selling and taxation of land properties. This computerized standalone application, as a repository of land value data is capable to providing easy access to the user/customer about the land information. The technology used for development is open source and hence offers easy modification and customization at user end also. The current version is developed for windows environment and can be used and installed in any windows based system with very less effort. The system can be utilized by the users interested in real estate market for the land procurement process. The system can also assist government agency for taxation purpose.

**Keywords:** Geographical information system (GIS), Real Estate Information System (REIS), Open source, Land valuation

### 1. Introduction

Development activity in India is increasing at a high rate and is only expected to increase further in the future. Rising urbanization offers opportunities for the development of real estate market. The growth in real estate industry is visible in every city. Land plays a crucial role in the life of people. Difference in position, fertility or natural resources make some locations and land parcels more desirable and valuable than the others. System of valuation provides control of real estate market. Property valuation is a process of identifying and assigning those factors that affect the value (Horsley, 1992). For the purpose of valuation, the valuation methods are classified as comparative methods, cost methods and interactive analysis method (Dale, et. al 1999; Rangawala et al., 2011). But for this study, valuation purpose is mainly for buying and selling the real properties. The valuation is done on the basis of parameters and rules set by the local governing body i.e. in the case of present study area District Collector, Bhopal & District Valuation Association. These parameters are used for the valuation of land properties for payment of registration charge of ownership. These parameters are per unit area called *circle rate*. This is defined for the different locations. These circle rates are taken as bench mark rates for this study. These rates are revised yearly by the District Collector in India.

GIS provides a technical platform on which market analysis as well as spatial representation of property information can be shown in the form of maps (Waytt, 1997). Maps improve the decision making capabilities of human being. Capabilities of GIS facilitate the management of geographic data, as well as it enables to

take full advantage of location information contained in these databases to support the application of spatial statistical and spatial econometric tools

The main objective of the study is to develop a GIS based system which facilitates decision making related to land valuation information. The sub objectives of the study are as follows:

- To create a spatial database of unit rate for real estate properties.
- To generate parameter based valuation of properties using GIS functionalities.
- To develop interactive application which enables prospective user in decision making related to land or real estate properties.

### 2. Study area and data used

#### 2.1 Study area

The study area is a part of Bhopal city, the capital of Madhya Pradesh, which is situated in Central India. The total population of Madhya Pradesh is about 7.26 crores. According to census of India, population of Bhopal has increased from 10,62,771 in 1991 to 14,37,351 in year 2001 at 35.24% increase and up to 17,98,218 in 2011 at a 25.10% increment. Population wise, it is the second largest city of Madhya Pradesh. Study area is north-east part of city having coordinates 77°26'12"E, 23°16'10"N at an average altitude of 427m from mean sea level. The study area includes Raisen road, Vidisha road and Ring road. The study is carried out along these roads for various land parcels for valuation purpose.

#### 2.2 Data used

The study is based on data that are collected from various sources including internet. The primary

requirement is the detail about land records in spatial format, which is to be valued. A land use map of the study area is also required for classifying the properties as residential, commercial, etc. The development plan of the study area viz. Bhopal city is also a crucial requirement which contains the data provided by the Town and Country Planning Department, Bhopal. For valuation purpose unit rates and rules of valuation of properties are required. For each year circle rates and guidelines for valuation of immovable properties under Bhopal district are announced by District collector, Bhopal, taken from website of Collector office Bhopal ([www.mp.nic.in](http://www.mp.nic.in)). The circle rates are taken as benchmark in the place of market rates and the guidelines are helpful in making parameters for the valuation purpose. But the rates vary from place to place in different wards, so a ward map is also needed because neither development plan nor land records are based on wards. The complete dataset used in the study is listed in Table 1.

### 3. Tools and technologies

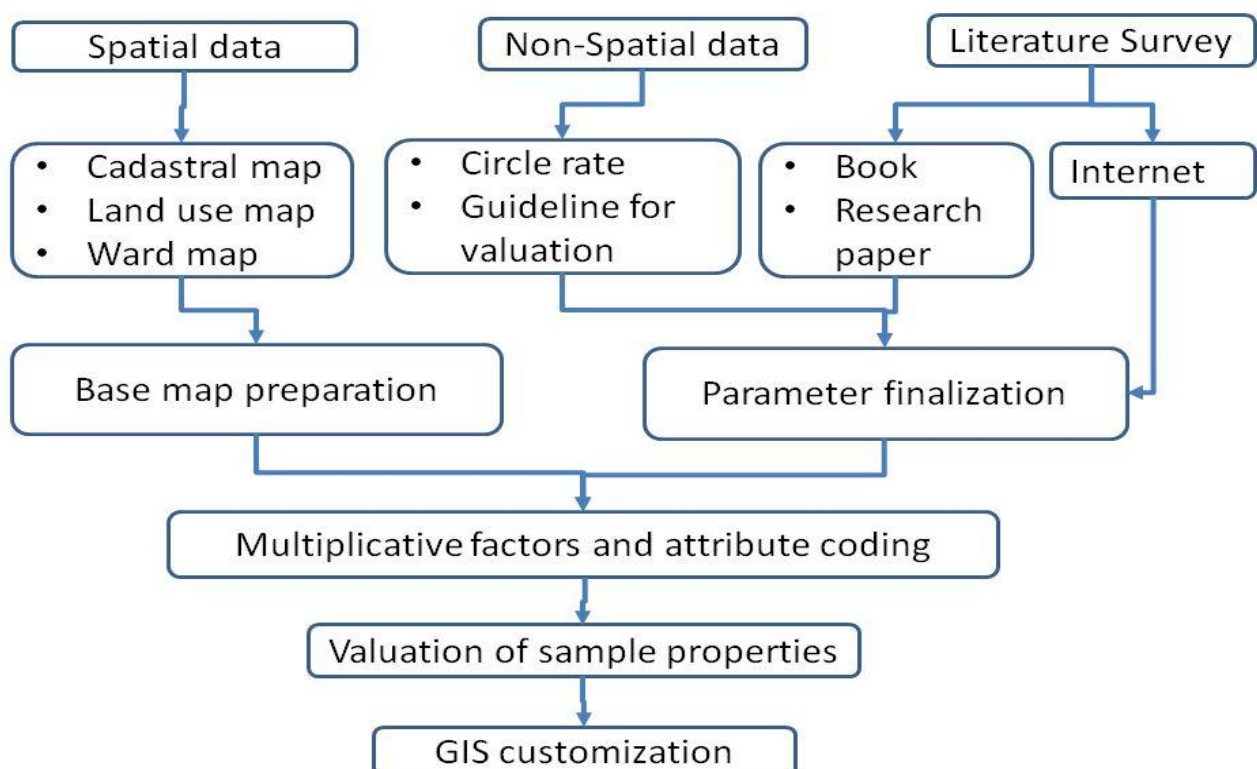
The tools and technologies used in the development of the software solution are listed in Table 2.

### 4. Methodology

The overall methodology adopted for the study is given in Figure 1.

**Table 1: Data sets used for the study**

S. No.	Data	Type	Source
1	Khasra Boundry	Vector	Wardmap
2	Commercial area	Vector	Landuse map
3	Industrial area	Vector	Landuse map
4	PSP area	Vector	Town and Country Planning Bhopal
5	Existing PUF area	Vector	Town and Country Planning Bhopal
6	Recreational area	Vector	Town and Country Planning Bhopal
7	Residential area	Vector	Landuse map
8	Existing Transport	Vector	Landuse map
9	Wardmap	Vector	Wardmap
10	Circle rate of Bhopal City	Text file	Wardmap
11	Satellite image	Raster	<a href="http://earthexplorer.usgs.gov/">http://earthexplorer.usgs.gov/</a> (ORBVIEW-3)



**Figure-1: Methodology of the study**

**Table-2: Tools and Technologies used in the study**

S. No.	Component	Specification
1	Operating system	Windows (32 Bit & 64 Bit)
2	GIS package	Map window
3	Programming language	VB.net
4	Database	File based(.shp)
5	Libraries	Map window active control(.ocx)

The data available for ward boundaries and road network was available in image form. These data are converted in .shp files by digitization. After base map, attribute coding was done which includes ward name, ward no., area for wards and road width, road length, road name for roads. This work was done in open source GIS and final base map was prepared. The available data was cadastral map which contains Khasra no. area, P. H. No. and village name. This map was further improvised by adding unit circle land rates applicable for various areas as per the guidelines for circle rates issued by administration of that area. Multiplicative factors are worked out for each of the parameter which affect the land unit rate and hence added to the base map file. The parameters and multiplicative factors as listed below:

• **Landuse**

Land use	Comme rcial	Indus trial	Agricul tural	Reside ntial
MF	1.50	1.50	1.00	1.00

• **Depth from road**

Depth from road	Less than 20 Meter	More than 20 meter
MF	1.00	0.75

• **Type of road**

Road type	National Highway	State Highway	Other Roads
MF	2.00	1.50	1.20

**5. Results and discussion**

The development of Real Estate Information System i.e. REIS using geospatial techniques has been carried out in the following stages-

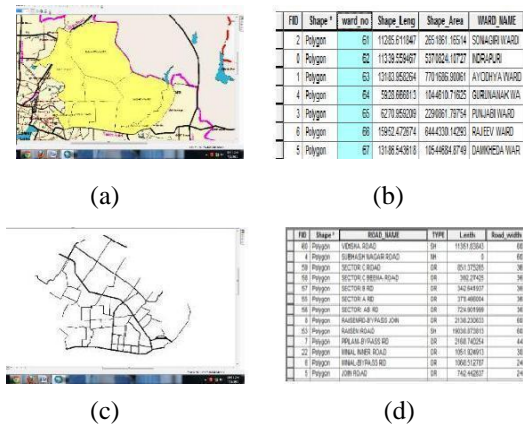
- Creation of geospatial database
- Valuation of properties
- Development of software solution.

**5.1 Creation of geospatial database**

A variety of database has been utilized in the study. First of all the wardmap was obtained from municipal corporation Bhopal. The map was scanned and georeferenced with the help of ground control points. The geo-referenced wardmap was converted to vector layer by manual digitizing. The vector ward map layer was attribute coded with ward name and population collected from census of India 2011.

Figure 2 shows the ward map and road map with the

help of the scanned and georeferenced wardmap. After digitization, an attribute table was prepared for the wardmap layer with the attributes ward\_no, shape\_length, shape\_area and ward\_name.



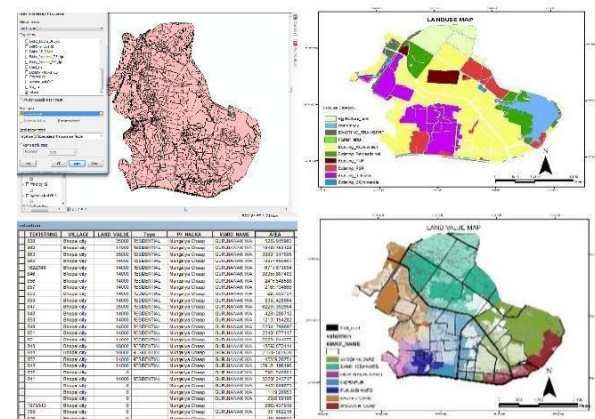
**Figure 2: (a) Digitized ward map; (b) attribute table of ward map; (c) digitized roads map; and (d) attribute table of road map**

**5.2 Preparation of ward wise land value map**

Ward map so prepared is used to assign the individual cadastral units to different ward the land values as per the Govt. guidelines and other attributes are coded in the attribute table with the help of Field Calculator tool. Field names in the value map attribute table are Khasra\_no, type, ward\_name, area, land\_value and PH\_HALKA.

**5.3 Finalizing parameters for valuation and valuation of sample properties**

The parameters affecting the value of any property are taken from the “Valuation Guidelines of Immovable Properties” issued by the District Collector, Bhopal. These guidelines describe various parameters such as depth from road, roadtype, land use etc, which are inputs for working out valuation. Every parameter has been given a weight and these weights are filled across the polygons in the attribute table of cadastral maps.



**Figure 3: Ward wise value map**



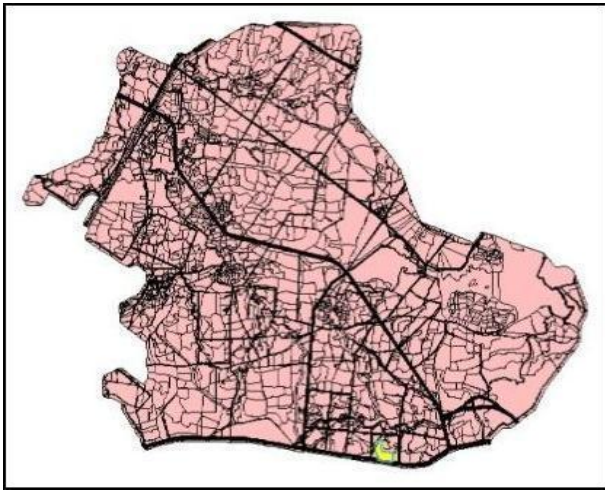


Figure 4: A sample land value map

Case 1	
Khasra Number	172
Patwari halka	M.P. Nagar 1
Land use	Industrial
Ward name	Indrapuri
Circle Land Rate (Rs./ Sqm)	33000
Land area (Sqm)	25772.14
<b>Multiplicative Factors</b>	
For Land use	1.5
For Depth from road	1
For Road type	1.2
For Area	1
<b>Value= Land area x Circle Land Rate x Land use MF x Depth from road MF x Road type MF x Area MF</b>	<b>1530865116</b>

Figure 5: Valuation of properties

#### 5.4 GUI designing and coding of basic structure of REIS

To fulfil the third objective, a software application has been developed using open source technology that facilitates prospective users to search a property according to their needs. In the present study a simple graphical user interface (GUI) is created wherein dynamic map are displayed and it allows to perform basic GIS operation and user-based queries (Figure 6). The GUI have been developed using visual basic programming language.

The query window is the main part of the application which has been customized to meet the needs of the user. The query window is linked with the database to fetch the requested results and to display it on the map window. The user interface contains basic display components like zoom-in, zoom-out, pan etc. It also provides the facility of spatial query and it provides the attribute data of any land parcel where the user has clicked. On click by the user on any part of the map, a new window pops up and the attribute information is displayed in that window.

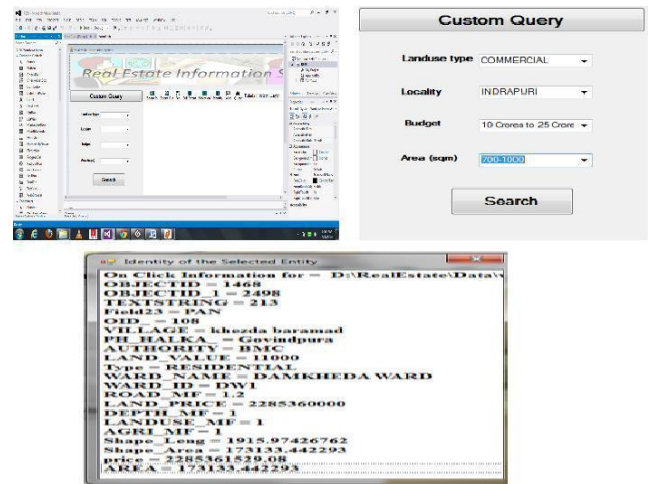


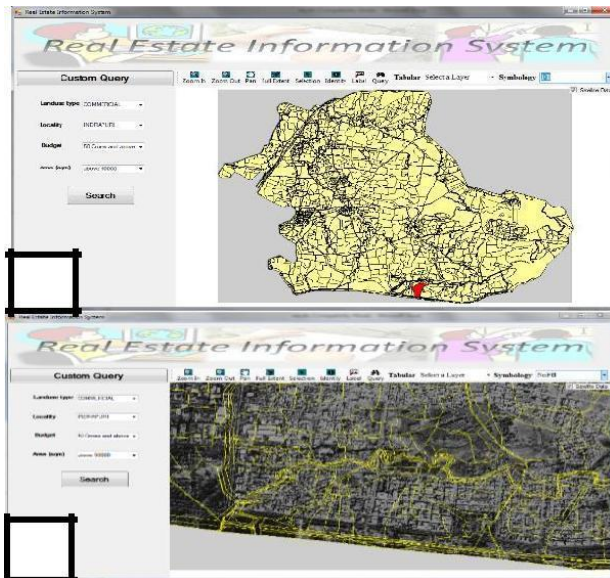
Figure 6: Graphical User Interface (GUI) of REIS

#### 5.5 Sample use case of REIS application

CASE 1: land type=commercial, Locality = Indrapuri, Budget (Rs.) = Above 50 Crores, Area (m<sup>2</sup>) = Above 50,000 m<sup>2</sup>, Result: One area selected.

#### 5.6. Discussion

The application (REIS) is developed for realizing an analytical system to study the real estate market by the user. It provides results based on the input and also can be used for finding costliest or cheapest properties in any particular area or in the city. Any kind of analysis can be done like comparison of values in same area or comparison of same extent of land in different wards. This study has provided the GIS based system to work out the valuation of open land parcels but further parameters and multiplication factors can be added for built up parcels owned by individuals so that entire valuation will become more scientific and customised. Creation of spatial database is very useful for valuation purpose and it can be recommended to prepare spatial databases for the government departments related to the land. It can help them to take decisions for their projects and can act as a base data for the further functions like Tax calculation, etc. by adding appropriate attributes. System integration or a development of centralized system for all the departments related to the land records is important so that benefit could be obtained from business as well as technical point of view. REIS can also be linked to other databases of different departments so that user can access the other types of data. This would save the resources, time and effort and can help in the fast decision making. This system can be improved by adding the market rate, which can help user a better understanding of the real estate market.



**Figure 7: Result of the sample use case query (a) overlaid on ward map; and (b) overlaid on satellite image**

## 6. Conclusion

A Real Estate Information System (REIS), which is useful for the valuation purpose, has been developed for standalone windows platform using open GIS. This can also be linked to other databases of different departments so that user can access the other types of data. This system can be improved by adding the market rate, which can help user a better understanding of the real estate market.

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