Applications of GIS: Property Tax Mapping and Management System

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Abstract:
Most city governments depend on the revenue collection from property tax to finance their infrastructure and city operations. Lack of these funds causes growth and progress to be delayed and reduces the economic potential of the city. By developing a GIS-based tax assessment and management system the city government is able to: check the total tax collected for a defined area like a ward; compare this against what would be expected to be collected from the ward; re-plan tax amount based on changing urban development plan and new construction; and develop more detailed system focusing on new development areas to improve tax collection.

For this purpose, author has been used an excellent tool i.e. Tax Parcel Editing Toolbar support to ArcGIS-10.3 for Desktop and developed by ESRI. Use of such systems have demonstrated an increase in tax revenue in towns in India by over 60% additional tax collection, better system of tax calculation and collection, and opportunity for private sector participation to work with governmental to increase efficiency in tax collection.

Keywords: Tax Mapping, GIS, tax assessment and management.

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Dr Kuldeep Pareta has obtained M.Sc. degree in Geography from Dr Hari Singh Gour University, Sagar - Madhya Pradesh in 2001, subsequently Ph.D. in Geomorphology, Hydro-Geology and Remote Sensing from same university in 2005. Presently, he is working as Head (RS/GIS & NRM) in Omaksh Consulting Pvt. Ltd., New Delhi. INDIA, and has have over 16+ years of research and development experience in the field of national resource management, geomorphology, hydro-geology, watershed modelling, and national disaster management. He has published over 60 research papers in various referred national and international journals, and four International books. He was conferred Prof. S.M. Ali Memorial Gold Medal in 2001 and MP Young Scientist award in the year 2004.

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1. Introduction

India has around 7,840 urban local bodies (ULB) including municipal corporations, municipalities, nagar panchayat. Mostly, but not all, these ULB’s are following standard manual techniques to collect charges. These are some general source of revenue for municipal corporations, municipalities, nagar panchayat. These are: exclusive taxes such as property tax, professional tax, entertainment tax, advertisement tax and revenue-shared taxes, all taxes on goods and services levied by the state government, other revenue sources such as value added tax (VAT), sales tax, stamp duty, electricity, purchase tax, luxury tax, taxes on lottery, betting and gambling, entry taxes in lieu of octroi, etc., Non-tax revenues such as user charges, trade licensing fees, FSI charges, betterment charges, impact fees and development charges.

There is no regular update or monitoring in the addition or removal of different units in those source of revenues. For example, in case of property tax there is no close monitoring of whether appropriate property taxes are made by owners on the addition of houses, additions of floors in houses, change of ownership etc. As a result, municipalities are seemingly in loss of large amounts of revenue. This paper is representing, how the GIS could help in efficiently monitoring this process and thereby stop the loss of revenue through effective enforcement of property tax practices. Property tax isn't being acknowledged to its maximum capacity because of poor evaluation rates of properties and weaker effectiveness in revenue collections. The biggest challenge faced by municipalities and local civic bodies today is to define better methods for property valuation, keeping a regular track on revenue collections and record losses on account of exemptions.

GIS could help monitor the property tax revenue by preparing a common platform that visually links all property-related data such as the number of floors in each building, the total constructed area of each building, individual plot areas, details of locality, and road facing details with the applied tax calculation principles. An efficient GIS can store accurate information on tax payables and revenue collection which can be monitored visually. It can send automated notices to tax payers periodically to update them about pending dues. Visual representation of the whole property tax system shall not only build an efficient and accurate tax collection mechanism, but also reduces the frequency of field visits for complaint redressal and other assessment purposes. This would also provide accessibility to all the related civic departments and shall enable a transparent and consistent system for tax assessment.

2. Study Area

Author has selected a small ULB i.e. Harda town of Madhya Pradesh to demonstrated the property tax mapping and management system through GIS application. Harada town is the administrative headquarter of Harda district in the state of Madhya Pradesh. The town is situated on Delhi-Mumbai railway line and has the advantage of direct railway connectivity to major cities like Delhi, Mumbai, Pune and Bhopal etc. The Project Area Boundary (Area of Interest - AOI) including the 17 villages is situated between 22.27 N Latitude, and 77.02 E Longitude to 22.40 N Latitude, and 77.15 E Longitude at the about 302 m above the mean sea level. As per Census of India (2011) the population of town is 74,268 comprising of 38,224 (51.5%) males and 36,044 (48.5%) females. The sex ratio in the city is 943 in the year 2011 which has increased from 907 in the year 2001. Presently, the municipal area of Harda town is divided in 30 wards.
The average rainfall of the town is 904 mm. It receives maximum rainfall during southwest monsoon period. The normal maximum temperature occurs during the month of May i.e. 44°C and minimum during the month of January i.e. 11.7°C. The average normal annual wind velocity of Harda district is 5.0 Km/hr. The town has developed along River Ajnal on a flat land. Major part of the town has flourished along the northern side of the railway line. The natural slope of the town is towards east-west. The entire district is drained by Narmada River and its tributaries. Thus the area falls in the Narmada Basin. ULB has total Geographical Municipal Area (Sq. Kms) is 5.83, and Number of Households are 14,835.

3. Data Used and Sources

The primary and secondary data sources have been used for this study. The primary data i.e. property tax survey and Socio-Economic Survey has been collected from field. The secondary i.e. Development Plan, Master Plan Map, CDP Maps, Sol Toposheet, Village Cadastral (Khasra) Map, Wards Boundary Gazette Notification, Slum boundary map, Tax Zone Document, latest high-resolution satellite imagery - WorldView-02 have been collected from linked departments / agencies. The details of different data layer and its sources are given in Table 1.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Data Layer / Maps</th>
<th>Year</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>CDP Maps</td>
<td>2011</td>
<td>UADD, Government of Madhya Pradesh</td>
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<tr>
<td>3.</td>
<td>Sol Toposheet @ 1:50,000 Scale: F-43 L/03 (Number of Open Series Map), 55 F/03</td>
<td>2009</td>
<td>Survey of India</td>
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<tr>
<td>4.</td>
<td>Village Cadastral (Khasra) Map</td>
<td>-</td>
<td>M.P. Land Records</td>
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<td>5.</td>
<td>Wards Boundary Gazette Notification</td>
<td>1995</td>
<td>M.P. Gazette Notification, &amp; Nagar Palika Parishad</td>
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<td>7.</td>
<td>Tax Zone Document</td>
<td>2013</td>
<td>Nagar Palika Parishad</td>
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<td>8.</td>
<td>CartoSAT-1 Digital Elevation Model (CartoDEM) Data @ 30m Spatial Resolution</td>
<td>2010</td>
<td>Indian Earth Observation, National Remote Sensing Centre (ISRO)</td>
</tr>
<tr>
<td>10.</td>
<td>Software Used</td>
<td></td>
<td>Tax Parcel Editing Toolbar support to ArcGIS-10.3 for Desktop and developed by ESRI</td>
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4. Property Tax Mapping

An efficient real property tax administration depends on data that is accurate, timely and economical to maintain. Building and maintaining the property inventory and attribute database are the most labor-intensive and costly function of the property tax administration. Tax mapping is a core element of any integrated real property administration and taxation management system. It established the link between the real properties in the field and the property assessment and tax records of the tax administration.

Tax mapping is a classical method of field operations for identifying real property units or “tax parcels”. Tax maps provide the public with vital real property information. Therefore, property or parcel location maps have been maintained manually in countries with “ad-valorem” real property taxation for quite some time. Tax parcel maps are fundamental to the appraisal (valuation) of real estate. They help to determine the location of
property, indicate the size and shape of each parcel, determine actual land use and help to discover undeclared properties for taxation purposes. Although tax maps serve as a general reference to property locations, they are not a substitute for official cadastral survey documents and should not be used in legal land disputes. They allow the establishment of a real property record system that can be adapted to data computerization.

Digital tax parcel mapping is the process of converting the paper map based part of the “fiscal cadaster” (cadastral base maps, property identification maps) into a digital form and maintaining and management the tax maps of local government units with the help of a GIS. Usually this is done parallel to the introduction of a computerized real property taxation management system. This process can be time consuming costly and not easy to manage sustainable, if process flow and purpose of the system is not analyzed properly from the start. However, if based on a prudent local needs and requirement analysis, the rewards in terms of better property management and higher real property assessment efficiency are numerous. Especially as a visual tool to produce for example “shame maps” in concert with other tax collection efficiency measures increases in locally collected taxes can be achieved. This can widen the local tax base considerably and hence will increase the financial options and the independence of local governments to invest in improved social service delivery and better physical infrastructure. In return, visible efforts in this field will improve the “tax moral” of local residents. At the same time the digital tax maps require the related database are regularly updated. The best way of ensuring this is to link the digital tax maps to the database used by an integrated tax administration system. This also holds true for the need to update maps when further spatial sub-divisions or consolidations are undertaken. Author has prepared several type of digital maps to analyze the property tax on each plot (Fig. 1).

Land Use / Land Cover Mapping: The knowledge of land use and land cover is important for many planning and management activities as it is considered as an essential element for modeling and understanding the earth feature system. Land use is defined as the any human activity or economical related function associated with a specific piece of land, while the term land cover relates to the type of feature present on the surface of the earth. Land cover maps are presently being developed from local to regional and national to global scales. The broad LULC showing built-up area, agricultural, forest, wastelands (including vacant lands) and other key physical features such as water bodies, canals, drains, rivers, major roads, railways etc. under municipal boundary. This can be used as ready reckoner for the decision makers of the Nagar Palika (Municipal Council) of the town.

Base Map of Municipal Council Area: A base map provides important background information and is typically combined with other map layers that represent operational information managed by a department and/or agency within local government. In some cases though, the base maps themselves may serve as a finished product that can be used in a map atlas or other hardcopy product. Base map for municipal area was prepared on the DGPS geo-referenced latest satellite imagery, toposheet, CDP maps, current master plan map, based on local survey and other input maps received from the ULB. This is conveying the information on all major physical features with reference names such as, main roads, bridges, city roads, lanes, railways, important land marks, water bodies, drains, canals, rivers, etc.
Figure 1: Various Thematic Maps Used for Property Tax Mapping

**Tax Rate Zone Map:** The tax rate zone map is prepared based on the notification “Property Tax Rate Sankalp” issued by the Nagar Palika. There are three types of tax rate zones i.e. Tax Rate Zone-1, Tax Rate Zone-2, Tax Rate Zone-3. The tax rate zone boundary map superimposed on the city base map of the municipal council area of town. This map will be used as ready reckoner for the tax collectors of the Nagar Palika of Harda Town.

**Property Mapping within Municipal Council Area:** A pre-condition for creating a digital tax parcel map is to define the desired spatial accuracy. Principally four different types can be distinguished, ranging from simple scanned maps to very accurate parcel maps based on the direct conversion of the primary field survey data. A typical procedure of digital tax parcel map generation consists of the following steps.

(i) Scanning or photo capturing of existing manual parcel maps - the paper maps will be scanned or photographed with a good quality digital camera. Special care has to be exercised to avoid distortion.

(ii) Image processing - the next step is to assemble a raster image that combines all images or scans of the individual parcel into a single parcel mosaic which covers the whole tax administration jurisdiction or the area of the tax mapping project.

(iii) Image geo-referencing - adjustment have to be made to enhance the “fit” or “overlay” of the composed parcel map with the topographic base map features. Often a GPS field survey will be done prior to the tax
mapping project in order to update control points and major physical reference features such as roads, irrigation canals or power lines. As additional control and rectification option is to use high-resolution satellite images or aerial photos as a backdrop for the geographic adjustment of the digital parcel map. Up-to-date high-resolution satellite images or aerial photos allow also the digitization of building footprints of the property. This is a very important additional graphic element of a digital parcel database, since buildings commonly are subject to real property taxation as well.

(iv) Digitizing of parcels - the parcel image mosaic is converted into a GIS usable parcel file by digitizing all parcel boundaries. This is done by on-screen digitizing.

(v) Labelling of parcel with a unique parcel ID number to create a link to the parcel database - the unique parcel identification number (PIN) links the mapped parcel polygon with the tax database. Normally a geographic code is used as PIN in order to identify the administrative location of the property.

(vi) Creating thematic maps such as land use map, payment status, type of ownership, assessed value, market value, tax delinquent - a major advantage of digital tax mapping is the generation of both standardized as well as custom made thematic maps. Examples are theme maps showing land use, payments status, type of ownership, assessed value market value or type of property improvements depending on the variables stored in the database. For the tax officer it is most convenient when these maps can be accessed within the tax administration system. An important task during the build-up phase of the digital tax database is the identification of non-plausible values and the checking of the digital database on encoding errors or faulty records of the assessor. Color coded maps show extreme and possibly faulty data records immediately.

5. Property Tax Management System

In many countries real property taxation revenue is one of the most important source of revenue of local governments. Today, the existing real property assessment and tax collection system is under pressure to increase its efficiency. Traditional manual workflows of partially redundant working steps cause delay and inconveniences for the tax paying public - a fact that certainly does not increase the willingness of property owner to pay their taxes regularly and on time. National governments are usually very interested that local governments increase their real property tax collection efficiency, hoping to reduce their dependency on national transfers and grants. Therefore, they often provide financial and technical assistance to modernize and increase the efficiency of the local government revenue generation system. However, computerization also requires the simultaneous redesign and adjustment of workflow processes otherwise the cost of data collection will increase.

In order to streamline the efficiency and lessen administrative costs, the computerization of the local real property tax administration system has gained high priority. Usually two connected elements or modules are at the core of the automation of a real property taxation system. A digital data management system for the storage of all taxation relevant records and automation of routine function, such as printing of tax collection and other reports. A digital tax parcel mapping component connected to the data management system.
6. Conclusion

(i) The major advantage of digital maps is their versatility - digital tax maps can be viewed and printed at any scale and customized with different labels to suit different purposes. (ii) A combination of numerical, textual and visual i.e. digital photos of properties including building can be embedded into the system and retrieved based on numerous spatial or statistical selection criteria. (iii) Digital maps can be maintained and updated much faster than paper maps. (iv) Digital maps require limited physical storage space and can be easily electronically backed up and protected against data losses (a serious problem in many tax administration offices is the lack of office space and safe map storage facilities. (v) Digital tax maps can be easily overlaid with other information layers such as land use planning zones, new road openings, buildings footprints or physical terrain features. This allows the performance of different analysis and planning tasks within a local government unit. The integration of digital tax parcel data into a multi-purpose land information system can create a versatile spatial planning and management system. The costs and benefits for establishing and maintaining such a system can be shared by different sections of the local administration. (vi) Cost of using high resolution satellite images to overlay digital municipal base maps are rapidly decreasing. (vii) Data and maps can be made accessible through inter and intra-net and can be easily shared in an electronic working environment. (viii) Transparency of local direct taxation can be enhanced.

References