Geographic Information System (GIS) and Multi-purpose Household Survey (MPHS) Based Tax Assessment Approach for manifold revenue generation in Mandav, Dhar District (M.P.), India: A pilot ward study

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Abstract: This study has been done under project entitled "Prepare Property Tax Register based on GIS & Multi-Purpose Household Survey its integration E-Nagarparishad with Technical Handholding Support" by M.P. Government. In Mandav, as a pilot ward i.e., Rampura Ward (ward number 05) was selected and that it aims to find out the comparison of revenue generation in terms of taxation for individual household properties in the same ward. Study ward had 98 existing house hold properties according to Nagar Parishad, Mandav records and after MPH survey it found 164. Using GIS techniques and existing tax assessment approach, in a totality 191% demand growth has been observed. 100% demand growth has been found in commercial properties followed by 39% growth in residential properties and 16% growth in mixed properties. Land Use and Land Cover map has also been made using drone imagery (resolution 0.35cm) and GIS techniques. In study ward agriculture land were found 35.44% of the total area followed by built-up area 27.16%, waste land 17.63%, water bodies 14.36%.

Keywords: Manifold Revenue Generation, Demand Growth, Land Use and Land Cover, Multi-purpose Households Survey and GIS techniques.

1. Introduction

Mandu, also called Mandava or Mandogarh, south-western Madhya Pradesh state of central India. Geographically, the city is located on graticules of 22.3271° N and 75.4053° E. It lies at an elevation of 2,079 feet (634 m) above sea level in the Vindhya Range, 38 miles (60 km) southwest of Indore, Madhya Pradesh. Demographically, Mandav is a Nagar Parishad situated in Dhar district of Madhya Pradesh. The Mandav city is divided into 15 wards. As per the population census 2011, there are a total 1,855 families residing in the Mandav city. The total population of Mandav is 10,657 out of which 5,373 are males and 5,284 are females thus the average gender ratio of Mandav is 983. As per the Census 2011, the literacy rate of Mandav is 53.7%. Thus Mandav has a lower literacy rate compared to Dhar district (59%). The male literacy rate is 63.44% and the female literacy rate is 43.94% in Mandav. Schedule Caste (SC) constitutes 2% while Schedule Tribe (ST) were 84.3% of total population in Mandav.

Developing and implementing a Web based GIS (Geographic Information System) application along with GIS database for better governance, improving operational efficiency and ease of interaction with citizens. 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 government to increase efficiency in tax collection.

India has around 7,840 urban local bodies (ULB) including municipal corporations, municipalities, Nagar panchayat (ESRI, 2017). In fact, every country works in the field of its economic development and pushes itself to become strong in terms of financial powers. This is a joint venture between the government and public (Lucas et al.,1994). Taxation is one such system that acts as a connecting loop (Jiang et al., 2021).

Property tax is a levy on property that the owner is required to pay to the governing body of the area where the property exists. For any development, property tax is one of the major sources of income state or country to cover the expenditure of development (Soeb et al., 2011). The local or municipal bodies are bound for the development of their administration, and without capital, it can become a challenge for them. Besides, taxation can be used as an urban management tool that can track land use, urban expansion and land market related to properties (Kundu et al., 2011). Also, GIS mapping has great significance in scientific research, planning, and management (Aronoff, 1989). GIS technologies can handle large volumes of data from multiple sources, integrating them to produce information in a spatial context through maps (Fedosin and Yamashkin, 2014). Mostly in city areas governments depend on the revenue collection from property tax to build up their infrastructure and so many operations in their municipalities areas. GIS-based tax assessment system for city government is spatial-based that able to

check the total tax collected for a smallest unit of the city i.e., ward. Designing GIS based Property Tax assessment (Singh et al.,2022).

Urban Administration & Development Department (UADD), Government of Madhya Pradesh has taken up a huge Municipal reform through various ULBs in the State. Project "Preparation of Property Tax Register based on GIS & Multi-Purpose Household Survey, its Integration with E-Nagarpalika and Technical Handholding Support" for Cluster LL/09 (RFP,2020). Mandav is one of ULB among them.

This assignment aims to keep transparency among citizens and urban local bodies (ULBs), genuine taxation for different types of house / roof structures and finally enhance tax generation in manifolds way through geo-spatial technology. GIS and Remote Sensing satellite imagery / drone images play a vital role to map every smallest property in larger scale. GIS is a computer based system of tools for effective and efficient storage, retrieval, and manipulation of spatial and non-spatial data for attaining efficient management and policy-making information (Bell, 2000). GIS can provide a platform to input spatial data and intelligence for planning and monitoring project implementation (Mathur et al., 2009). This objective has been achieved by so many processes i.e., collection of property/holding data, verification (from existing municipal records) on the basis of various parameters of each property within the municipal/ward boundary, database generation, linkage with the base map. Further, the scope also includes design, development & hosting of property information system. A study was conducted for property tax collection in Madhya Pradesh, 2015, stating that traditionally, ULBs have tended to rely on fiscal transfers for most of their financial investment requirements (Awasthi and Nagarajan, 2020). Partly to address the huge investment gap at the municipal level, there has been a continuous increase shown in fiscal flows to ULBs from the federal and state levels. However from 2007/08 to 2012/13, grants to ULBs grew 4.6 times, which is unprecedented (Awasthi and Nagarajan, 2020). In an another study conducted for Ranchi Municipal Corporation (RMC), as on March 31, 2017, an amount of Rs 49.28 crore was collected as property tax against the total demand of Rs 54.18 crore including arrears of Rs 6.09 crore by RMC (Awasthi and Nagarajan, 2020).

2. Study Area

Rampura Ward (ward no. 05) has been selected for pilot ward for study (Figure 1), located between 75.394701° E to 75.402442° E and 22.345762° N to 22.337435° N. The ward has old settlements which observed traditionally rich. The ward has been attracted by so many old (more than 100 years) monuments which makes religiously enrich. Total existing property according to municipal records are 98. After completion of survey total new property has been found 66 and it has been observed the tax collection will be increased 191 % by the new taxation implementation.

3. Objective

The main objectives of this study are to enhance manifold revenue generation through GIS mapping and MPH survey of individual properties. Which will help to become self-sustain financial, planning and management capacity of the ULBs through provision of valid, reliable and credible spatial and non-spatial information.

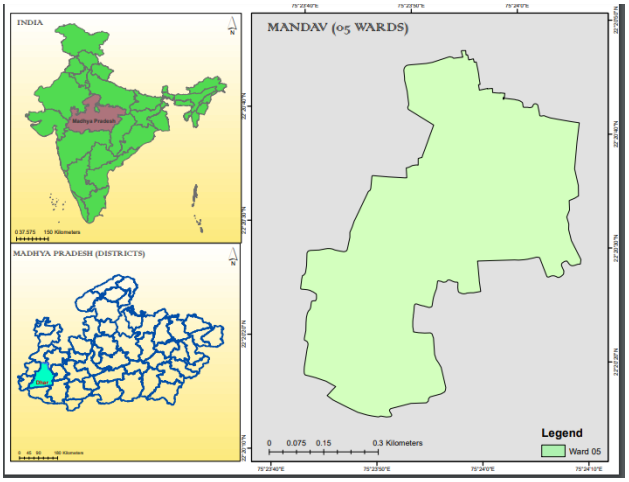

Figure 1. Location map of study ward (Rampura ward), Mandav

The objectives could be more elaborative as; Improve revenue collection through ascertaining un-assessed and under assessed properties, develop a common base map that would be used by all participating sections/ departments within ULB for detailed mapping and the development of Municipal GIS, establish a strong visual link between the location of a property (building & plot) onto the GIS base map and its corresponding tax data which would provide a spatial dimension to the tax records through proper mapping of properties, Provide a baseline for performance measurement. (This point is one of the objectives of GIS based MPHS survey.), allow spatial or distributional analysis of service levels, revenue generation and social composition, particularly identifying the location of poor and socially excluded communities. The distributional or spatial analysis could be further enhanced through GIS technology, provide updated property tax database which would ultimately update the property tax demand collection registers and collections of property tax as per updated demand register.

In other hand, this study also aims to reduce the crack in unidentified and under-assessed properties, revenue leakages in the form of unauthorized water connections, and few details regarding end-users the revenue survey has been taken place for social and economic development of the region. Some of the main issues are property tax, water supply, consolidated tax, and social welfare and poverty programmes.

The advantages of the project is to an efficient real property tax administration depends on data that is accurate, timely and economical.

4. Datasets

Mainly drone and google earth satellite imagery have been used for this study. The details is given below (Table 1).

Table 1. Datasets used

Sl. No.	Data	Year	Source	Resolution
1	Drone	2021	UADD, Bhopal	0.35cm
2	Google Earth	Various years	Google Earth	0.65 m

5. Methodology

For this study methodology has been divided in four parts, i.e., Data used, Data collection, Flow diagram and Creation of Unique Identification Number.

5.1. Data Used

UADD has provided Drone image (0.35cm. resolution) of April, 2021 for this study. Google earth data also have been used. Each property demarcated on the satellite imagery is known as 'Parcel'. Each parcel gets digitized as an output of shapefile in ArcGIS platform. Some important landmarks are digitized in points, linear features (road, railway, drain, etc.) are digitized in polyline, plots/houses/trusts/ religious places are digitized in polygon. These features are linked spatially with its corresponding property details.

The captured data needs to be automatically updated into the Geo-Database as per the database structure defined and agreed before the start of the project. This has been done under proper guidance of Database Administrator and MIS expert so that any kind of error can be eliminated from the source itself. Proper care should be taken to avoid any data redundancy and duplication of data. It has been properly checked that all the field of the given database should be entered and any blank entry should be avoided. For this it is suggested that proper customized data updation software module should be prepared so that any manual error can be eliminated from the system. In this proposed case, survey is done through hand-held devices and form-based application, thus the data processing has been done on the output to bring it in line with the required format.

5.2. Data Collection

Data collection plays an important role for imposing the property tax. It aims to collect all the property details of individual households. Here it is done by two mode i.e., SATAT application (online) mode and hard copy mode (offline mode). An App named as "SATAT" has been provided by UADD, Govt. of Madhya Pradesh, which aims to develop the mobile application to perform the property survey in different areas and capture the survey data in one place (server) in online mode. Surveyor self-registers their profile and perform new property survey as well as update existing pre-captured details of survey. About hundreds of individual property details has been collected through this app including property photographs and location. Final database is stored in server and it can be easily downloaded in excel form. Latitude and longitude help to authenticate the collected data to administrator.

5.2.1. ***Hard Copy Format***

Individuals property details are taken, incorporated in this format, randomly keep signing by property responder during survey at ground level. The complete filled format of all the individuals are handed over to respective ULBs. It aims to keep the records for verifying while some one has any objection in taxation.

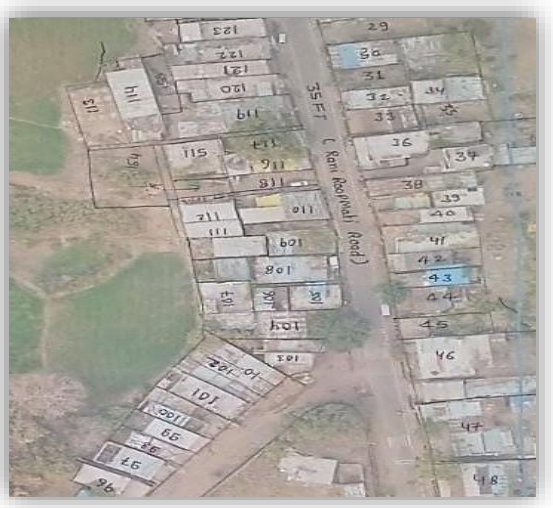

Figure 2. Depicts the parcel /parcel no. of individual property on Drone image of the study area

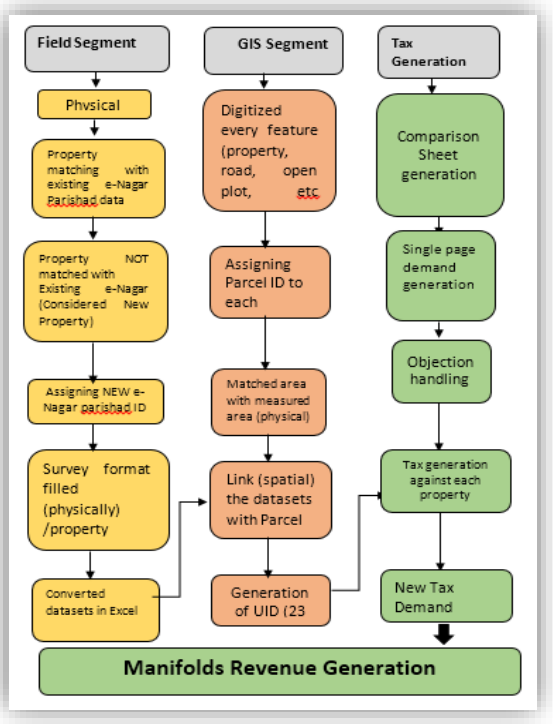

Figure 3. Methodology adopted for the study

5.2.2. ***Parcel No./Parcel ID/ Map ID***

On provided satellite imagery / drone image, according to house structure, covered area of individual property, the same area is demarcated on the map. This demarcation is called "Parcel". Particular number is given on the map and that number is known as "Parcel ID or Map ID" (Figure 2). This parcel ID is also mentioned on hard copy format as well as on SATAT application. In final stage, this parcel ID plays an important role to link all the property details

spatially. A number of information is depicted on the satellite imagery hard copy, i.e., road width, important land mark, chouraha name, water body name (if there), etc. This hard copy of map is also submitted along with hard copy format data to the respective ULBs.

5.2.3. ***Flow Diagram***

Methodology adopted for this study is divided in three stage i.e., Input, output and outcome. Methodology for property tax collection has been completed in three steps i.e., Filed Segment, GIS Segment and Tax Generation Segment. Detailed flow diagram of methodology has been shown in Figure 3.

5.2.4. ***Field Segment***

Field segment is covered the physical survey. Ward Inspector helps to match all the properties within the ward with their existing E-Nagarparishad IDs. The IDs, which does not match with existing IDs, it has been considered with New Property Tax IDs. Survey format has been filled with all the details of property owner. The data has been filled on SATAT App. (described earlier) parallel with hard copy.

5.2.5. ***GIS Segment and Tax Generation Segment***

In this segment involves Remote Sensing and GIS (Geographic Information System). UADD has provided the Drone Image. Before starting the field survey, every property has been mapped on drone image (hard copy) and given a particular number, which is known as Parcel ID or Map ID).

In other hand, every existing feature (road, park, open plot, building, etc.) are digitized within particular ward boundary in Arc GIS software. In every digitized property the same parcel or map ID has been entered as on hard copy and that parcel ID is spatially linked with final validated datasets (here validated datasets means the existing property matched with e-Nagar Parishad ID), after linking both datasets, the every details which was filled on the field on SATAT, can be seen by a single clicking on individual parcel in ArcGIS.

After completion of Field Segment and GIS Segment final segment is Tax generation Segment. Nagar Parishad Mandav has shared the tax calculation method and following the steps the new tax demand generated. Comparison (old demand versed new demand) sheet has been generated. It shows how many properties added newly in existing property and in existing property how much taxable amount increased. Then the single tax demand page has been generated for every property. If someone opposes against new tax amount, in that case that property again will be surveyed under the supervision of Revenue Inspector. This is a kind of objection handling. Now fresh tax generation for every property is available and ready for implementation as an output of the project. Finally manifolds revenue generation observed.

5.2.6. ***Creation of Unique Identification Number***

Creation of unique identification number (UID) aims to generate a UID for every individual properties. UADD have suggested a Unique ID (UID) 23 digits numeric code for each plot/ property i.e. “01010010001010100001001”, where 01 represent the State Code, 001 represent the Division code, 001 represent district code, 001 represent ULB Code, 01 represent Zone Code, 01 represent ward number, 00001 represent parcel number and 001 represent the property number. Apart from this there been a GIS link ID of 11 digits. i.e. “00010100001”, where 0001 represent ULB Code, 01 represent Ward number and 00001 represent parcel number (RFP; 2020), shown in Table 2.

Table 2. Depicts UID for individual properties (sample)

State code		Division code			District code			ULB code			Zone code		Ward No.		Parcel No.					Property No.		
2	3	1	5	2	1	6	3	1	7	0	0	1	0	5	0	0	0	0	1	0	0	1

6. Result and Discussion

Pilot ward (Rampura ward number 5) had 87 residential properties and after survey it became 144 however there were no commercial properties in the existing records, but after survey found two new properties. Ward had 98 existing property according to Nagar Parishad records. After survey total properties has become 164. New demand for properties-wise growth analysis (existing property Vs surveyed property) has been done for Rampura ward in Mandav. 100% demand growth has been observed in commercial properties followed by 39% growth in residential properties and 16% growth in mixed properties. This result is only for pilot ward (Rampura; ward number 5). Mandav city is divided in 15 wards. Some of wards are being surveyed first time. The datasets have been prepared on GIS platform and it will be used by spatial analysis in many other purposes to infrastructures development, government plan implementation, etc. It is hoping that new tax generation will be manifold and multiple times tax generation will be increased. Table 3 shows comparison of demand for Rampura ward, Mandav.

Table 3. Manifold growth in revenue generation

Sl No	Property Type	Old Property	Old Demand (in Rs)	New Property	New Demand (in Rs)	Growth (in %)	Growth (in Rs)
1	Residential	87	1,19,920	144	1,98,488	39%	78,568
2	Commercial	0	0.00	2	7,238	100%	7,238
3	Mixed	10	27,146	12	32,575	16%	5,429
4	Other	1	0.00	6	0.00	0%	0.00
Total		**98**	**1,47,066.41**	**164**	**2,38,303.05**	**191%**	**91,236.64**

6.1. Land Use / Land Cover Map

Land use and Land Cover (LULC) map has been prepared for the pilot ward. Agriculture land covers maximum area in the ward i.e., 35.44% followed by built-up area 27.16%, waste land 17.63%, and water bodies 14.36%. Figure 4 shows LULC map of the Rampura ward however Table 4 shows the LULC area statistics. Land use and land cover map will help in this study to get a perspective view of the city in planning purpose, view for the probable demarcation of each properties and existing of particular properties in study area.

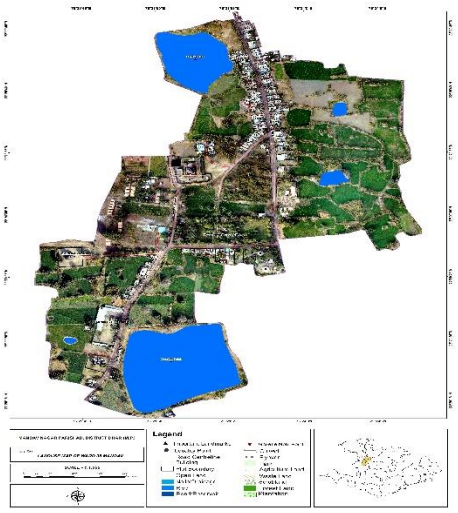

Figure 4. Land use and land cover map of study ward

Table 4: Statistics of land use and land cover map of Rampura ward

SL No	Land use	Area (in Ha)	% Area
1	Built-up	10.23	27.16
2	Vacant	1.11	2.94
3	Water Bodies	5.41	14.36
4	Waste Land	6.64	17.63
5	Agriculture Land	13.35	35.44
6	Road	0.92	2.44
Total Area		37.66	100

7. Conclusion

Mandav has 15 wards. Only one Rampura ward (ward number 05) has been selected for the pilot study. This work has been done with Remote Sensing, GIS techniques and multiple household survey methods. Drone imagery were used for this study which helps to map the properties in better way.
This study has been done under project entitled "Prepare Property Tax Register based on GIS & Multi-Purpose Household Survey its integration E-Nagarparishad with Technical Handholding Support" by M.P. Government.

Study aims to find out the comparison of revenue generation in terms of taxation for individual household properties in the same ward. Study ward had 98 existing house hold properties according to Nagar Parishad, Mandav records and after MPH survey it became 164. In a totality 191% demand growth has been observed. 100% demand growth has been found in commercial properties followed by 39% growth in residential properties and 16% growth in mixed properties. Land Use and Land Cover map has also been made using drone imagery (resolution 0.35cm) and GIS techniques. In study ward agriculture land were found 35.44% of the total area followed by built-up area 27.16%, waste land 17.63%, water bodies 14.36%. Some of wards are being surveyed first time. It is hoping that new tax generation will be manifold and multiple times tax generation will be increased. It has also been observed that application of Remote Sensing and GIS techniques has the best output in terms of manifold revenue generation.

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