Indian Cadastral Survey System - Comparative Study

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Abstract- The Indian land measurement system is very old having traces from Indus Valley Civilization whereas cadastral surveys was started in India about two centuries ago based on the survey systems prevalent in England and Europe. This survey was done for the purpose of collection of revenue. Survey of India (SoI) was established in 1767 to carry out revenue survey till 1904. After 1904, the states of India were made responsible for cadastral surveys. Each state has evolved its own system of cadastral survey for revenue collection, which calls for the improvement in cadastral System for a country like India using modern technologies in surveying and mapping. The study discusses the different categories of cadastres and comparative survey of cadastral System operational in India and few other countries. Then analysis and discussion of literatures is carried out to suggest improvements in Indian system. Literature pertaining to cadastre is collected to gain perspective and in depth view of cadastral system.

Index Term- Cadastre, Dynamic Software System, Dynamic Parameter, Computerisation of Land Records, National Land Records Modernization Scheme

1. INTRODUCTION

A cadastre is parcel-based land information which has complete up-to-date records of land in term of rights, responsibilities and restrictions. The cadastre is often the principal source of information about ownership rights in land. Even when compiled for fiscal purposes, the record of payment of tax may constitute evidence of ownership of land. The basic unit of the cadastral record is the land parcel, which is popularly known as plot. For the better administration, it is essential to keep the record of land parcels and their attributes. The cadastral system helps in better management of urban and rural area. The ownership of land helps and other attributes helps in good governance and development.

The Cadastre supports in land taxation, real estate convincing, and land redistribution. Effective land management requires land information namely land resource capacity, land tenure and land use. The cadastre provides following information as below:

- It provides the information about people owning the parcels of land.
- It provides the information on rights, restriction.
- It provides the information about the parcels in term of location, size, improvements and value.

2. CATEGORIES OF CADASTRE

A cadastre provides updated, latest and consistent information about land parcels. Cadastre can be divided into following categories based on the different information.

2.1 Juridical/Legal Cadastre

Juridical Cadastre/Legal cadastre deals with documenting the rights in land. It relates these documents to the rights on land. Juridical cadastre supports all forms of property rights and restrictions. It contains a detailed description of the parcel in different form like survey maps or measurements. This information is nothing but spatial information & related attributes which is defined as a written record for the specific land.

2.2 Fiscal Cadastre

Fiscal Cadastre is a cadastre which deals with administering land tax and valuation. The required information can be gathered through the different survey directly or indirectly. Other sources can be used to develop and maintained the fiscal cadastre like details of land ownership and their property boundaries.

2.3 Multipurpose Cadastre

Multipurpose Cadastre is a cadastre which is very popular these days and mapped with the location and different types of physical features. These types of cadastre contained man-made objects and associated natural features. These physical attributes are associated with each land parcel, abstractions, surveying and mapping data. It can help to refer the parcel. The multipurpose cadastre helps in planning for utilities, land information and development management. There are the following advantages and benefits of multipurpose cadastre.

- an improved convincing system;
- an improved cadastral survey system;
- improved land use planning and land management and environment management;
- improved management of publicly owned lands,
- reduction of duplication,

- better control of land transactions; and
- improved Sustainable development.

However, in multipurpose cadastral system, some of the datasets can be value add from other sources which may create following issues.

2.3.1 Legal liability

Data held within a land registry or cadastral offices are often guaranteed by the State whereas other sources of data hold no liability. What guarantees can be given for the quality of data that have been processed and analysed in a GIS.

2.3.2 Data ownership

Where different agencies, both government and private, pool their data, questions of ownership and the control of these data may arise. Who owns the added value derived from data integration?

2.3.3 Data protection

In many political systems citizens have rights to privacy, hence the use of data for purposes other than that for which they were collected may be constrained. Access to land-related data may be politically or socially sensitive and may need to be controlled by appropriate legislation.

2.3.4 Data quality

While the raw text data for land administration should be fit for purpose, old survey data may be less accurate either because technology has improved or because boundaries have legitimately changed since the original survey.

2.3.5 Adoption of standards

Data sharing is synonymous with the adoption of common standards, but agencies may be reluctant to change their own well-tried and tested procedures or to delay implementation until legacy systems can be replaced.

2.3.6 Data pricing

Procedures for the pricing of products and services and for sharing the costs and benefits of data integration must be consistent amongst agencies. Prices should bring benefits to the data producers without discouraging the use of their data. Too often prices are influenced by the cost recovery levels for a specific agency rather than wider economic benefits.

3. INDIAN CADASTRE SURVEY

The recent concept of cadastre as a basic tool for stimulating economic and social development in both rural and urban areas, and for ensuring effective administration and planning in the public sector although recognised, is rather new to India. In fact, Indians have all along used the term "revenue surveys" synonymously with cadastral surveys. In view of the existence of an ancient urban culture in India, the practice of cadastral surveys must considerably pre-date the discovered earliest records of about 1000 A.D. Towards the middle of the 16th century, Raja Todarmall of the Court of Akbar, introduced a system of land revenue assessment based on land measurement and classification, the latter depending on continuity of cultivation and soil fertility. Simple rectangulation geometry was used, angle measurement generally not being employed. It is amazing that in the next four hundred years, the methods have changed very little in India, although the British period occupied a good portion on the time scale. This is more to be wondered at, if one considers the Indian achievements during the same period in the fields of geodesy and topographic mapping. Land tax was the main source of revenue to the East India Company, and hence little time was lost after occupation of territories to start the cadastral surveys. Phillimore's "Historical Records of the Survey of India" [6] show that the Board of Directors maintained considerable pressure and urgency for the completion of cadastral surveys; and special procedures were developed to expedite the work, often at considerable expense of accuracy. The British were careful not to disturb the routines of folk life while they dealt with the warring Kings or Subedars. Hence they adopted the existing cadastral system. Further, since different units of measurement were in force and regional variations had already modified survey practice, it is not difficult to account for the lack of homogeneity in the cadastral survey systems as they developed in the three principal Presidencies of Bengal, Madras, and Bombay. In some areas the British adopted a system of land management and tax collection of the pattern that some of the Moghul emperors and other native kingdoms had used. Known as the zamindari system, it appointed permanent tax collectors or zamindars. The system assured the inflow of money into the treasury at no expense to the Government, which therefore gradually lost interest in updating, improving or even the proper keeping of cadastral survey records. The zamindars assumed wide powers to ensure collection, charged heavy commissions to sustain luxurious living and assumed the role of moneylenders against mortgages of land. It was only a matter of time before the zamindars established themselves as landowners, and the farmers became tenants, often in deep debt. The zamindars now employed agents to collect revenue. Finally, several levels of collectors, sub-collectors, tenants and sub-tenants grew up [3]. Large scale cadastral surveys and land registration came much later but could not rescue the farmers from grim exploitation. In other states, Todarmall's cadastral system known as the Raitwari under which the actual cultivators of the soil were the persons directly responsible for annual payment of the fixed revenue was retained. Unfortunately, this good system, through no fault of its own, was unable to prevent the exploitation of the illiterate needy peasant who attracted moneylenders and other exploiters.

In some States including Himalayan State of Uttrakhand, the parcels are surveyed with GPS and integrated with satellite image of CARTOSAT. The mapped cadastral Information is being used by peoples through agrikiosks. Peoples using this can obtain relative image and details of the parcel. Parcel survey accuracy cannot be ensured by this adapted method, which can be used for creation of land information system. Land information system created is useful for farmers. Land information system can be adapted for cadastral mapping with accuracy improvements through Total station survey of study area. Ahlawat's (2008) work is appreciable for creating land information system in Himalayan region which is a tough task. The system can benefit land management and administration if the satellite images are updated at regular intervals. The cadastral information system, when updated properly, can be used for crop assessment of production and damage. From this literature, the significance of satellite image, when combined with cadastral information system, can be identified which can be adapted for cadastral photogrammetric

study. Land registration in many countries is carried out with graphical or photographic cadastral application. Land parcel registration method without obstructions from satellite and aerial images are discussed in this paper. The study was carried out in Azerbaijan. Ahn & Song (2011) discuss the effectiveness of digital photogrammetric techniques for built up urban areas. Rural areas must be surveyed with Total station and GPS. The developments in the field of Geographic Information System (GIS) technologies have given a new insight in addressing a variety of land development, management, and planning activities for better use of land in resource management. The High Resolution Satellite Imagery (HRSI) is showing its usefulness for cadastral surveys due to which traditional cadastral and land registration systems have been undergoing major changes worldwide (Zahir and Muhammad, 2012). The traditional surveying concept has taken up into new shape from discipline oriented technologies, such as geodesy, surveying, photogrammetry and cartography into a methodology oriented integrated discipline of geo-information. Such methodologies are based on Global Positioning System (GPS), Remote Sensing (RS), and digital photography for spatial data acquisition (Tuladhar, 2005). Rao et. al., (1996) has been demonstrated overlaying of cadastral maps over the merged product of IRS 1C PAN and LISS III data. Similar study has been carried out by Raju et. al., (2008) stated that the potential of very high resolution satellite data is high in urban cadastral mapping. Kumar et. al., (2013) has been demonstrated updation of cadastral maps using high resolution remotely sensed data.

Now the cadastre system in modern India has been changed to manage the land record system. There are the important key elements of a modern cadastre

- Publically Available
- Dynamism/Updation
- Large scale maps
- Updated Registers
- Based on Coordinated survey system
- Unique Identifier for each parcel
- Correct Information
- Complete Cadastre
- Have unambiguous definition of parcel boundaries both in map form and on the ground.

4. CADASTRAL SURVEY TECHNIQUES USED IN OTHER COUNTRIES

Greenfield (2001) evaluated the accuracy of digital orthophoto quadrangle in the context of parcel based GIS. Beltran & Belmonte (2001) discuss digital cadastre application in Spain used for finding crop irrigation area. Crop irrigation area is estimated using LAND SAT TM image with cadastre map in vector form. The accuracy attained through this method is above 90%.

Blackie (1974) has carried out disquisition of modern cadastre requirements. The basic requirements for cadastral system are resurvey, mapping, coordinates, compatibility, updating, maintenance, information accessibility, cooperation and automation. The requirements connect various aspects in one roof and are called as a cadastral system.

Blagonic & Prosen (2007) have demonstrated the importance of applying cadastral data for environmental protection. Protection of environment can be carried out easily by using cadastral maps. Cadastral maps are used for environmental protection through identification of land use.

Cagdas & Stubkjaer (2008) showcases the potential of cadastre to be considered for doctoral research. Research should be carried out in portals of cadastre such as land administration, land tenure, land registration, development and policy making. The aspects of cadastre which should be considered for research are explained. The methodology suggested to frame cadastral research is useful for framing methodologies.

Cagdas & Stubkjaer (2011) deal with the design of research methodologies to be considered for doctoral research. The paper also identifies key issues for cadastral systems which need focussed research for effective solution of problems. The authors, by their experience, recommend cadastre avenues for consideration for doctoral research leading to development of cadastre. This paper concludes by identifying avenues for cadastral research. This paper is useful for identifying avenues of cadastral system requiring research.

Cheng et al (2002) explains a method for the improvement of cadastral data quality. The method contains orthogonal conditions, line conditions, distance condition, data procession, graded adjustment, blunder detection and thresh holding method for gross errors removal.

Chrisman & Yandell (1988) showed a methodology to identify errors using a simple statistical model, which considers parcels as single units. The adjacent boundaries are not considered. The present methodology has some limitations. So the authors suggest another model by Markov's process through topology. The paper provides proof of the statistical relationship between coordinates and coordinate errors. The coordinate adjustments of parcels with straight line boundaries are possible with this method. The methodology used in this for this work is good, but lacks results and validation of the model.

Conto et al (2009) explain the method for creating WEBGIS application of Venice. Cadastral information of Venice is collected, as also information from other countries and processed together in WEBGIS to get historic cadastral data base. Historic cadastral database provides information of cadastral systems adapted in Venice during various kingdoms rule. Changes in concept of cadastral systems can be studied from this WEB application for cadastral developments. This paper is useful for understanding the evolution of cadastre from title identification tool to multipurpose cadastre.

Demir & Çoruhlu (2008) elaborated the problems of converting graphical cadastre to digital cadastre. These problems are addressed with poor graphical cadastre, which comprises 20% of land records in Turkey. Turkey cadastral systems are upgraded by private partnership through Land Registry and Cadastral Information System (LRCIS).

Demir & Yavuz (2009) discuss cadastral services available in Turkey with private sector participation, which is monitored with limited control over cadastre systems. Dimopoulou & Gogolou (2013) explain the use of international Land Administration Domain Model (LADM) for managing of Hellenic Archaeological Cadastre (HAC).

Elekes et al (2008) explain cadastral maps and accuracy of city Cluj-Napoca in Romania. Romanian cadastral maps are accurate to ±3 metres, which can be fitted into modern systems with a few horizontal adjustments. The maps obtained for adjustments are from 1912 and 1940.

Fong and Conrad (2002) have elaborated cadastral systems of South Africa, Singapore and compared them with the cadastral system of Hong Kong. Recommendations for new cadastral systems of Hong Kong are carried out. These systems are improper and dispute continues to surface. The systems need revision and require a proper method of adjudication, registration, boundary demarcation and definition.

Haanen & Sutherland (2002) describe an e-cadastre which was carried out under land online project. The cadastral system was integrated with geodetic network and the land title system. The proposed cadastral system contains digital submission, validation, new geocentric datum and integration of old cadastre.

Hasanzadeh (2010) explains the need for modern cadastre through application of GIS in the development of sustainable cadastre. Cadastre design through GIS for the future of Iran is also discussed. The author details the present conditions of Iranian cadastral system and its limitations.

Ibraheem (2012) describes the potential of GIS in creating a land information system, which also uses digital photogrammetric techniques and field surveying techniques to solve unmanageable mapping conditions in Iraq. The author has created a land information system using GIS for small part of Baghdad around Nahrain University and for the University. He explains the appropriate ways of creating land information system using satellite images, GIS and GPS.

Ivankovic (2008) has described utility cadastre for local governance of the town Osijek in Republic of Croatia. Local governance of utility depends on the cadastral information available for the parcels.

Kelm et al (2014) present the advantages of using Unmanned Aerial Systems (UAS) for data collection. Data collected through UAS are used to create digital maps within a short period of time. The maps can be used for land administration functions like urban planning, tax assessment, tax collection, natural resource management, environmental monitoring and disaster mitigation.

Khalaj & Lashkari (2010) discuss the ineffectiveness of cadastral system in Iran in the use as land information system. Urban plans of Iran are failing due to lack of information during urban planning. Urban plans should be created by using a multipurpose cadastral system. The authors have elaborated solutions to be adopted for creating multipurpose cadastral systems and urban plans.

Paudyal (2007) describes the status of cadastral system in Nepal. The author has evaluated the condition of the cadastral system with benchmarks of cadastre 2014. A pilot study of Banepa municipality was carried out for creating cadastral information system. The study consists of development of 3D parcel registration system and accurate land registry system. The accuracy of survey should be less than a centimetre in the pilot study. The author evaluates the system using six statements for the Nepal cadastral system among various evaluation methods. The author concluded that by adapting current methodology in survey department of Nepal, Cadastre 2014 AD vision can be achieved.

Polischuk (1994) discusses the development of an integrated territorial information system, which has been developed in Unified Modelling Language. This language represents the classes and objects. Classes are subdivided into territories and objects are classified under classes. The author has classified all types of land details under Unified System of Classification and Coding of Cadastral Information (USSTC). He has carried out extensive work on the cadastral system for creation for Integrated Territorial Information System (ITIS). ITIS is useful in serving the purpose of cadastre. The methodology proposed can be used for developing cadastral information system.

Popescu et al (2010) use satellite images for study of earth resources. Earth resources of soils are carried out through remote sensing using this methodology. Satellite images of scale 1:50000 and cadastral maps of 1:25000, 1:10000 are used in this study. The satellite images are processed, rectified and geo referenced in software for image processing and mapping. Cadastral maps are overlaid in the satellite images and environment resources available are correlated in the maps.

Tubkjaer (1992) shares his experience of creating multipurpose cadastre in Denmark. The methodology shares legislation changes which led to cadastral system development. The author analyses the various naming methods for parcels with variations associated in each methods with advantages and disadvantages.

Tamim (1995) explains a method for digital cadastral overlay apart from the existing methods. The existing methods are digitising and resurvey. Digitisations of existing cadastral maps are cost effective and time saving but with poor accuracy. The resurvey costs are higher, time consuming process but vary high on accuracy. The author suggests the least square adjustment method by comparison with available coordinates of the land parcels. The author considers constraints like areas, widths of streets, continuous curves and lines, unknown angles. The method also considers variables which are unpredictable through detailed survey and provides acceptable results. This makes it adaptable for cadastral system adjustments. The method adopted by the author is suitable for conventional cadastre adjustments.

Zevenbergen (2002) describes the role of land registration and cadastral systems. The cadastral systems and the land registration in many cases did not function independently and the cooperation between these two societal needs is not smooth. The author uses a systems approach to study land registration system and cadastral systems. This approach is focussed on the technical, legal, and interrelations of the organisational aspects. The study is carried out on the basis of the case studies of the four countries Netherlands, Indonesia, Austria, and the Ghana.

5. INDIAN CADASTRAL SYSTEM: PRESENT SCENARIO

Scenario since First Plan, Planners have been advocating proper maintenance of land records as the basis of good administration. This was reiterated in the Second Plan and Third Plans. The Sixth Plan envisaged the complementation and updation of land records from 1980 to 1985. According to the Seventh Plan document, "Land records form the base for all land reform measures and therefore, regular periodic updating of land records is essential in all states." The Eighth Plan (1992-1997) and the Ninth Plan (1997-2002) have also envisaged the fulfilment of all five-year principles of National Land Reforms Policies that is the abolition of intermediaries, tenancy reforms with security to actual cultivators, redistribution of ceiling, surplus land consolidation of holdings and updation of land records. Subsequently in the 73rd Amendment to the constitution it has been mentioned that computerisation of land records is an essential step to achieve decentralised planning and effective administration.
Subsequently, during 1988-99, centrally–sponsored scheme on computerisation of land records (CLR) was started with 100% financial assistance as a pilot project in eight districts. The scheme was extended to all districts. The records of rights are already computerised in more than 25 States, where farmers can take copy of their land records from tehsil computer centres and even download the copy from website. However, maps digitization and its integration with record of rights .i.e. Khasra & Khatoni is still away from reality in many states.[35]

6. ISSUES WITH CURRENT INDIAN CADASTRAL SYSTEM

In analyses of India's cadastral system, the basic problems are the rural poor people. These people generally face the problem of accessing land and security of tenure. The advancements in a changing social and financial scene, India at freedom acquired a semi-feudal agrarian framework. The proprietorship and control of land was exceptionally amassed in the hands of a little gathering of landowners and middle people, whose primary expectation was to extricate most extreme lease, either in trade or out kind, from inhabitants.

When a plot is acknowledged in a village map, the system provides the data identifying with that plot by getting to the database momentarily. Similarly aggregation of land data and related information to create larger amount information is conceivable. For instance, utilizing the essential information on plots, it is conceivable to deliver village information and the village maps. Similarly aggregation is possible at the tehsil and district levels also. For any good cadastre system it is necessary for time at any desired location planning is a reconciliation of social and economic aims, of private and public objectives. It is the allocation of resources, particularly land in such a manner as to obtain maximum efficiency. In this way, planning is therefore the art of anticipating change and arbitrating between the economic, social, political and physical forces that determine the location, form and effect of urban development. In the rural environment, the aims of the planners are similar, though the strategies for their realisation will be different.
In order to find solutions to above issues, Indian Government in 2008 revamped Computerisation of Land Records(CLR) programme to include automation/resurvey of cadastral maps using modern cadastral techniques under National Land Records Modernization Programme (NLRMP). Seeing the availability of modern techniques and technologies for cadastral survey and automation, all States & Union Territories in India have been asked to ensure comprehensive management of land records by undertaking the following activities [36]:

- Carrying out Cadastral Survey/Resurvey using modern survey technologies namely GPS/ETS, High Resolution Satellite Imagery and Aerial Photogrammetric approach depending up land terrain and existing maps.
- Linking of attribute data with the cadastral maps through a GIS.
- Ensure real time updation of Land Records
- Integration of Land Records and Registration.
- Implementing Land Titling System in the country.

Many Indian States have started using modern survey techniques in creating updated maps. These maps have been integrated with Records of Rights, land use, registration, banks and revenue courts ensuring implementation of comprehensive land management system in the country. [35]

7. CONCLUSION

The research work focuses on cadastral survey systems in India as well as foreign countries. The literature survey is done to assess the economic and social demands for the people to fulfil their need. The survey concludes that some countries are much more behind and some are much ahead to meet the socio-political and economic requirements. The cadastral survey system explores the defined techniques & standards which are applicable in developed countries and can be helpful in developing countries. These techniques can be adopted without much consideration and efforts as is being done in India.

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