Improvement of Cadastral System: Scope in Nepal

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Summary

The cadastral system in Nepal is developing continuously with gradual speed. Cadastralsurvey started with chain survey and in due course of time, plane table survey was adopted for the survey in spite of its limitations in accuracy and time. Currently, total station has been practiced in few municipalities for this purpose. The paper focuses on the probability of modern data handling technology; Total station, Global Positioning System (GPS), Participatory GIS and Remote Sensing as the appropriate technology for the improvement of existing cadastral system of the country. Current situation of the cadastral system and the technology used, its shortcomings and the suitability of the proposed data handling technology are discussed in the paper.

1. Introduction

Nepal has come through its long history in land survey and management. The land survey was started with the help of chain in 1930 B.S. (1873 AD). Gradually, structural development of the governmental offices working on land administration began and thus, map based land recording system was started after the establishment of Cadastral Survey in Bhaktapur district in 1980 B.S. (1923 AD) After Land (Survey and Measurement) Act, 2019 B.S. (1962 AD) came into effect with the objective of preparing up to date land ownership records that were essential for the collection of land revenue and information about the tenants, the maintenance of map based land records system came into practice. Plane table survey has been adopted and is commonly used for the cadastralsurvey. The problem with the technology is that it cannot give the expected accuracy and also is bringing lots of land disputes. However, the technology is not only the reason for such issues. Moreover, some of the maps are prepared in free sheets without control points, there is always problem in matching the cadastralof one sheet with another, bringing disputes among the villages and districts as well. However, thoughts are emerging to apply modern technology in this field. The paper analyses about some good options for the betterment of the cadastral system.

The objectives of the paper are:

- To analyze technology applied in the field of existing cadastral system in Nepal
- To identify shortcomings of the applied technologies
- To propose the better probable data handling technologies to improve the existing system

2. Cadastral system of Nepal

The cadastral system in Nepal mainly initiated to collect land revenue for the government by identifying the landowners and its tenants. Cadastre has been being gradually established district by district since 1964 (1907 AD) (*Acharya, 2011*).

During the time, cadastral survey was carried to identify the landowners, tenants and to determine the types of land. Three types of land are distinguished: (1) private, (2) public and government, and (3) trust (*Acharya, 2011*).

According to www.cadastraltemplate.org, cadastral systems in Nepal comprise the following major components:

- Cadastral Maps - The graphical cadastral maps at the scale of survey that are identified by the systematic map sheet number and included main features in the parcel.
- Field Book - The field book identify the landowner (s) of each parcel, which is based on the evidence produced during registration of the parcel.
- Land Ownership Certificate - Two copies of land ownership certificate are prepared, the official copy is termed as *Jagga Dhani Darta Sresta*, kept in office and the second copy is termed as *Jagga Dhani Darta Praman Purja*, distributed to the concerned owner.
- File Maps - During the process of land transaction when the parcel is too small and if it is not possible to plot in the map after fragmentation of the parcel, a file map of this parcel will be prepared in a separate sheet in larger scale.
- Plot Register - Plot register is information of each parcel which has been fragmented.

At present, the concept to convert these cadastral maps into computer based digital form has been developed and started in some of the districts. The cadastral maps of 52 among 83 district survey offices have been digitized. The customized application of Arc map termed as SAEx (Spatial Application Extension) has been used for this purpose. However, lack of continuous update of the digital database during the course of transaction has made the database out of date.

2.1 Status of Cadastral Survey

During the initial stage of cadastral survey, nationwide geodetic network was not available and hence the cadastral survey for 38 districts was carried out in the free sheet which is also called as island maps (*Figure 1*). The scale of the map was 1 inch to 100 feet. As the network of national control system was established, cadastral survey for remaining 37 districts was done on the controlled sheet (*Figure 2*).

Figure 1: Cadastral map in free sheet

Source: Acharya, 2011

Figure 2: Cadastral map in controlled sheet
Source: Department of Land Information and Archives

Recently, resurvey of one district among 38 has been completed in controlled sheet. Preparation of a series of cadastral maps of the whole Nepal has been completed with mapping of villages as single block (*Adhikary, 2002*). The total number

of parcel is 24,300,000 (approx. including village blocks). Approximately, 9000 ha of village blocks are remaining to be surveyed. A concept has been developed to carry out the survey using Total Station so that it reduces the number of disputes, increases the accuracy of mapping and supports the establishment of land information system (parcel based cadastral information system). The program has been implemented in two municipalities (Banepa and Dhulikhel) since 2006 AD (cadastral survey finished in Banepa).

2.2 Data Handling Technology

2.2.1 Cadastral Survey

Cadastralsurvey was started using chain in the ancient time. Gradually, the technology shifted from chain to plane table survey. By then the plane table became commonly adopted technology for cadastral survey. Initially, since geodetic control points were not established, cadastral survey was done in free sheets as island maps in the scale of 1 inch to 100 feet. 38 districts among 75 were surveyed in free sheets. Initiation of the network establishment started from 1967 (1910 AD)(*Adhikary, 2002*). A geodetic control network having different orders has been established throughout the country by triangulation method. Then after, the cadastral survey was conducted in controlled sheet using fourth order control for the remaining 37 districts. Resurvey of one district was completed in controlled sheet. Thus, now 37 districts in free sheet and 38 in controlled sheets.

The different scales of the cadastral maps prepared in controlled sheets are 1:2500 scale maps for the agriculture land, 1:1250 scale maps for the semi urban land and 1:500 scale maps for the urban land (*Adhikary, 2002*) with permissible error of 62.5cm for 1:2500, 31.25cm for 1:1250 and 12.5cm for 1:500 scales (*Department of Survey, 2003*).

Since plane table have some constrains in aspects of time, cost, clarity and security, use of total stations for cadastral surveying has been practiced in two municipalities. Parcel Editor, customized software for Arc map is used to process the data acquired by total station. 100 Total Stations obtained from Japan Non Program Grant Assistance (NPGA) have been distributed to different district survey offices for the further extension of the technology in other parts of the country.

2.2.2 Shortcomings of the technology used for cadastral survey

Any country follows the technology on the basis of their affordability, ability and need of it. Further, cadastre contain more data on land (also none legally recognized interest) which may not have official character (*Dekker, 2003*). So, the success of the cadastral system can be measured in different criteria as clarity, security, timelines (and completeness), fairness and cost (*Williamson, 1994)*. In spite of the limitations in security, clarity, durability and accuracy, Nepal adopted the plane table survey because advanced technology were very costly and at that time there were not enough human resources trained in other advanced technology. However, plane table survey has different shortcomings as follows:

- **Old technology**: It is very old technology which requires extensive field work as well as office work.
- **Time consuming**: The survey task consume huge amount of time since the surveyor needs to go to field and the helpers with staff needs to go around every parcel. Then in the office, he need to do inking over the lines drawn in the field thus need to give double time for single parcel.
- **More human resources required**: Surveyor himself can never complete the cadastral survey. He needs helper to hold the staff. In the case of Nepal, in the hilly areas, surveyor also hires helper to carry the equipments thus increasing the need of human resources.
- **Costly:** Cost of equipment may be less in comparison to modern technology but the operation cost meets with that of the modern technology. Cost of materials, cost for extra human resource, abstract cost for time and accuracy makes it more costly.
- **Less effective and inefficient for handling:** The area of the parcel is calculated manually. So we may not get the desired accuracy. The original map is prepared within some permissible error. When we do inking over it, the error is never minimised but the same or rather increases. Also the accessories of the plane table are quite inefficient for handling. Today, all the modern technology had replaced the technology and we may not find the accessories of plane table survey like telescopic alidade for maintenance in future if required.
- **Customer's dissatisfaction:** The cadastral survey in Nepal was started in 1964 A.D. with an objective to implement Land Reform Policy and to generate land revenue. At that time land value was low and the methodology of mapping adopted was suitable to meet the requirement

of national policy. In one way or other these cadastral maps have served as a basis of fiscal cadastre. The ever increasing demand of public regarding the more accurate cadastral maps for legal purpose is hard to be addressed by the current cadastral maps.

- **Less secure: physically and technically:** Since the maps produced by plane table survey is graphical paper map, it is not secured physically to arrange in the place or duplicate storage to make it safe from any sort of disaster and also to ensure that unauthorised person cannot damage or change the information. According to Cadastre 2014, "Paper and Pencil – Cadastre" will have gone (*Kaufmann and Steudler, 1998*). So plane table survey is technically unsecured as well. We may not have the equipments, neither pen, ink nor paper in future.
- **Weather dependent:** The survey is totally weather dependent. We cannot work on rainy days, neither on foggy days. Also because of shimmering problem we may not be able to do the survey in mid sunny day.

3. Choice for Data Handling Technology

Accuracy, the degree of conformity with set standards, is observed in cadastral surveys which are very important because, among other things, it helps surveyors to determine equipments and methods to use (*Eugene, 2005*). The options available to the surveyor for carrying out a cadastral survey are either ground survey methods or aerial survey (including remote sensing). The choice depends on the basis of equipments needed, techniques used, accuracy requirements, personnel, time and cost necessary to accomplish the surveys. Graphical (plane table) method has been useful in the past. New sophisticated, scientific and advanced technological instruments which are faster, more accurate and cheaper, have came over the past. However, we should not forget the reality that many of the systems appropriate for developed western countries are neither appropriate nor can they be afforded by developing countries and the major obstacles to cadastral system tend to be management issues, not technological issues (*Williamson, 1994)*. Still, four of the best suited alternate for earlier technology are discussed below.

3.1 Total Station

Application of total station in cadastral survey is increasing. This is highly efficient and accurate for parcel cadastralsurvey (*Tuladhar, 2005*). The technology can be applied for urban as well as rural area in spite of its minor disadvantages. The major limitation for the application in Nepal is the lack of the professional with limited knowledge in handling this technology. As for example if we compare between the cost of operation for this technique and the traditional plane table survey, it remains almost same if we don't consider the price of instrument. It further gives improved accuracy of cadastre and also requires less time for data post processing. Since it gives the digital data, we don't further need to worry about digitizing the acquired data. Also, another positive part is that we can get both numerical and graphical data at a single time.

It provides positional accuracy in centimeter and can be applied for measuring fixed boundaries. It provides better accuracy compared to other traditional techniques. By using this technique, required accuracy (12.5 cm or less) can be achieved. Thus only the trained manpower are required to adopt this technology.

3.2 Global Positioning System (GPS)

The use of GPS has changed the ways surveys and thus can be used in the same way as electronic total stations and direct measurements made between corners and returns directly computed values from the observed baselines (*Londe, 2002*). This is another alternate technology for efficient and accurate parcel cadastralsurvey (*Tuladhar, 2005*). Real Time Kinematic (RTK) GPS is the tool that could survey more points in less time. An accuracy of centimeter level can be obtained from this technology. Reference stations and phase measurements are needed to achieve this accuracy. On the basis of active reference systems connected with telecommunication network, precise coordinates can be acquired which is very useful for cadastralsurveying. Since high accuracy is highly costing, cadastral surveys with this method may be more costly. Availability of control point network all over the country is the positive aspect for the application of GPS.

By this technology, cadastral survey can be done quickly without an additional control point surveying and works out an accurate result of centimeter level without environmental limitations (*Ji-jeon, 2010*). The technology is best preferred in open terrain. In cases where sky obstructions were high, GPS-RTK can have some problems with receiving the signals. However, offset method can be employed to overcome the problem (*Mustafa and Khairudin, 2004*). The technology can come up with output of centimeter accuracy which meets the required

accuracy but bit expensive with respect to accuracy.

3.3 Remote Sensing

The use of high resolution remote sensing data like of Quickbird, Geo Eye and IKONOS can greatly enhance the on scale map generation and verification (*Alexandrov et. al, 2004*). The use of satellite images is considerably less expensive than the aerial pictures (*Oğuz, and GAZİOĞLU 2006)*. It can be used mostly for rural area where land value is low and small scale (1:2500) cadastral map is sufficient. Use of remote sensing may give relatively rapid, cost effective and mass production in comparison to field survey techniques and further advantages are provision of historical records (*Tuladhar, 2005*). However, since the cadastral survey of whole country is already finished and digitization of the analogue maps are on the way, the technology can be used more focusing on updating the existing cadastral maps.

According to Alexandrov*, et. al (2004),* the difference between superimposition of vector objects from the available cadastral information over the ortho-rectified image are within the obtained maximal displacement and RMS error. Extraction of the parcel cadastralcan be done more easily in multi-spectral bands and the spatial objects such as buildings, roads, rivers and other physical objects are easily extracted from both multi-spectral and panchromatic bands (*Tuladhar, 2004)*. Regarding cost for satellite image, there are other organizations which have satellite images funded for different projects and that can be shared. For the technical cost (software), Free/ Libre Open Source Software (FLOSS) can be adopted.

3.4 Participatory GIS

Participatory GIS are cost effective and considered to have superior effects in terms of relevance, usefulness, sustainability, empowerment and meeting good governance *(McCall, 2004).*This is the technique where local people are also involved in preparation of the maps. This approach can be used to re-establish the destroyed land records. Good example can be seen through the successful completion of land records re-establishment of different districts like Mugu, Khotang, Palpa etc. where official copy of land ownership certificate (Sresta) were re-established from the proof of the ownership provide by the respective owners. However, resurvey was not done in these areas. Regarding the cost, in comparison to above stated techniques, it is cheap since openly available google maps can be used for this purpose. Printed google images can be taken to the field and demarcation of the cadastralcan be made in the field with close consultation with the local people. This approach is more people centered than technological as it focuses on incorporating community views and understanding in GIS *(Mandara, 2007)*. Thus, this technique can be used for example, resurvey of Achham/Arghakhanchi where maps were destroyed during the conflict and need to be resurveyed. Since local people are directly involved in cadastraldemarcation, cases of land dispute also decrease. The technology may not be suitable for cadastral survey of the urban area but could be very efficient where quick rehabilitation or re-establishment of land records are required like that of destroyed area. The approach has been successfully implemented in Ethiopia. Enhanced technology is the use of digital pen. The surveyor goes to the field with the printed image and the pen. There, he digitizes the cadastralin presence of community which reduces the time for re-digitizing.

4. Conclusion

Since the development of cadastral system is very gradual with the use of plane table survey, quick action is necessary to shift the development of cadastral system and thus appropriateness of the four advanced technology are discussed. Without introducing modern technologies in the field of cadastral survey, improvement of cadastral system will never be efficient and effective. The options can have priority according to the accuracy, time, cost and security of the system.

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