USE OF GIS BASED TECHNOLOGY FOR COMMUNITY FOREST BOUNDARY SURVEYING IN NEPAL

K.P. Acharya
Research Officer
Department of Forest Research and Survey
Kathmandu, Nepal
GPO Box 9136
Email: kpacharya1@hotmail.com

KEY WORDS: COMMUNITY FORESTRY, SURVEYING, CHAIN AND COMPASS, PHOTOMAPS, GIS

Abstract: The main forest management policy in Nepal is community forestry. In community forestry, forest boundary surveying is a mandatory activity required for the formal hand over process of the forest area to the local community. Five different boundary-surveying methods are in practice in community forestry. The most commonly practised surveying system being the Chain and Compass survey. In this system maps are generally prepared by joining the straight lines with little or no references. Consequently such maps are less informative and less useful to rural people. On the other hand, CF in future requires surveying and mapping of a huge number of community forests for the hand over process and also for the up dating of the existing Operational Plans. To prepare quality maps and to meet this target within limited time there is a need to replace efficient and effective surveying techniques. As in Nepal land ownership receives highest social respect especially in the rural area where community forestry is being implemented. However, boundary surveying has received little priority and occupies little discussion within the forestry sector in Nepal. The paper suggests the need for more discussion and interpretation on the issue. It is recommended to explore the potentiality of combining existing surveying system and GIS based techniques in CF surveying.

INTRODUCTION

The main forest management strategy of Nepal is Community Forestry (CF). The Government has declared its full commitment to CF through the Master Plan for the Forestry Sector (MPFS), the *Forest Act 1993* and the *Forest Regulations 1995*. Forest boundary surveying and mapping is an important tool to support CF. However, it is one of the least discussed and debated issues within the CF. It is concerned with the separation of boundaries between forestland and private land. The practices of excluding forest area from forest area will promote more forest encroachment. While the attempt of surveying encroached forest area to be included in community forest area will ultimately invite conflicts during hand over. Hence handing over a part of a national forest without considering encroachment is a usual practice. This process should be reviewed, discussed and appropriate alternative is inevitable. Once the forest area have been encroached, it has become nearly impossible to reclaim due to lack of accurate and legally acceptable maps and records and lack of field demarcation. The surveying of community forest boundary is an obligatory activity for hand over process in CF. Existing legal and operational instruments demand a copy of a surveyed map included in the Community Forest Operational Plan. Regarding the methods used for forest boundary surveying, there are no restrictions. The surveying methods presently being used are chain and compass, sketch maps, use of cadastral survey map, Orthophotos and Global Positioning System (GPS). The most commonly practised surveying systems in the CF process are Chain and Compass followed by the use of Cadastral Survey Map (Acharya, 2001).

Types of surveying

The selection of surveying method is influenced by the interest of different donor supported project areas. For example, Churiya Forest Development Project has used the GPS; the Nepal-UK Community Forestry Project (NUKCFP) introduced Orthophoto Maps as an alternative to the

existing boundary surveying practices. In the past decade, the Nepal-Australia Community Forestry Project in Sindhupalchok and Kavrepalanchok districts heavily promoted sketch mapping. Keeling (1994) argued that in Baitadi district cadastral survey maps is easily understandable by the users and has high demand. On the other hand the forest technicians are most familiar with chain and compass survey and are quite enthusiastic to conduct it and produce a recent map.

The uses of aerial photographs for various purposes in rural areas for community development works have been reported from different places. For example Jordan, 1998 S. Groten, 1997 Ridgway, 1997 Seppanen and Acharya, 1995; Fox, 1989. The experiences on the potential use of aerial photos and photomaps for participatory planning and in a boundary survey of a community forest in the Western Dhaulagiri hills are reported by Mather, 1997, 1998, 1999 and Mather et al 1998. Acharya and Boer (2000) conducted a detail study on the use of photomaps for community forest boundary surveying in 2000 in Dhalulariqi hills of Western Nepal. It has been shown that photomaps are an excellent non-literate media and robust participatory tools that can easily attract local people. They argued that there is huge potential for the use of photomaps for participation process in CF however there are some constraints to adopt the use of photomaps for CF boundary surveying. The strengths and weakness of photomaps observed for boundary survey were as follows:

Table-: Summary of the potential strengths and weakness of photomaps for the use of boundary survey (Acharya and Boer, 2000).

Strengths	**Weakness**
Informative: Contains all pictorial information including forest and villages, all details visible	**Legality**: Legally not accepted for boundary identification associated with private land
Participative: Gather crowd of people, initiate and promote participation	**Costly:** Requires high investment, sophisticated equipments
Time efficient: Quick	**Accessibility**: Located at Project Office, production is highly technical
Manpower efficient: Required few technicians	**Sustainability**: High cost, highly technical, technology transfer
Relatively accurate: Geographically corrected	**Adaptability:** New technology (unfamiliar)
Simplicity: Easy to understand to literate and non-literate people	**Reliability:** Encroachment not seen, boundary unclear, scattered patches may leave or added, only once every 10 years, reference point not always clear, difficulty in delineating boundary in continuous forest crown cover, scattered patches may left or added in a unclear map, all boundaries at the field is not known
Acceptability: Mapping process clear to users, boundary demarcation and marking over transparencies by user themselves	**Others:** Low quality production, difficulty in locating reference points and small land features like streams within the forest, limited number of people (6-7) can participate at once and some may dominate the process, shadow confuses users and it is difficult for people with poorer eye sites.

Authencity of map in Nepal

The boundary of a CF may adjoined with the boundaries of many individual private lands. Therefore the legal recognition of map in question may be an important consideration in CF. According to the Land (Survey measurement) Act 2019, Cadastral survey maps *(Napi naksa)* are the only legal basis for the demarcation of land ownership in Nepal (HMG, 2019). The provisions in that Act authorised the Survey Department to survey parcel boundaries and distribute land ownership certificates to the legal owners. Realising this, First National User Group Workshop has recommended the use cadastral survey map in solving the demarcation disputes (Subedi, 1993). The present land

surveying system by the Survey Department does not cover mapping of forest boundaries and forest parcels. Forestlands are surveyed only when they fall within the periphery of private lands. Thus surveyed system produced two types of Cadastral maps namely controlled and uncontrolled. The uncontrolled maps show private land in a blank paper, which makes it very difficult to identify forest patches. The use of this map in the districts with uncontrolled references is difficult for CF surveying.

Preferences of a surveying method

The choice of a surveying technique may depends upon a number of parameters such as time efficiency, cost involved, accuracy, simplicity of the method, trustworthiness, clarity of end results and legal status of the surveying technique. The findings by Acharya and Boer (2000) suggest that the time taken for chain and compass survey is significantly greater compared to use of Cadastral survey map. However, the actual time depends on the terrain condition, number of stations and size of the forest. On top of the time efficiency, use of Cadastral survey map requires fewer numbers of surveyors such as Ranger and Forest Guards in the survey team. Cadastral survey map had received highest trust rating compared to other survey techniques. It was found that uncertainty over legal recognition associated with other techniques was the main reason behind it. The use of Cadastral survey maps is the cheaper method.

The use of orthophotos generates more participation than chain and compass, and Cadastral survey maps. Moreover, it is equally time efficient compared to the use of Cadastral survey map. Keeling (1994) claimed that Cadastral survey map is easily understandable by the users and has high demand. However, it could be very difficult for a ranger to work with this map with out a good orientation. On the other hand the forest technicians are most familiar with chain and compass survey and are quite enthusiastic to conduct it and produce a recent map (Acharya and Boer, 2000). In the present context of community forestry where the rural people are the forest managers, the map must include more references and details than those prepared for forest technicians. A CF map must include forest location, size, north direction, legends, appropriate scale and references. In addition including landmarks such as temple, forest road, rivers, streams and quarries, etc can produce a user-friendly map.

Table 2: Choice of a survey methods and trustworthiness among different stakeholders of community forestry.

S.N.	Survey techniques	Stakeholders	Simplicity criteria	Rank	Trustworthiness criteria	Rank
1.	Photomaps	DFOs staff	Ready made map with desirable scale, details visible, needs little walking, surveying and data analysis is not necessary	2	Clearly visible details and land features	3
		FUGs	Details visible, simple to illiterate	1	Actual landscape is seen at once	3
2.	Chain and compass survey	DFOs staff	Easy to survey, survey materials are available in Range Post, surveyed in presence of users, old users can delineate boundary, recent map and area	1	Forest boundary clearly seen on the ground, self-surveyed more trusty	1
		FUGs	Prevent forest encroachment, boundary can be seen at field.	3	Field survey is carried out according to users discussion	2
3.	Cadastral survey map	DFOs staff	Get prepared map, easy to identify private lands, no need of surveying and data analysis, calculated area available.	3	Legally accepted	2
		FUGs	Forest boundary delineated	2	Legally accepted	1

Present status of maps in community forestry

Acharya (2001) mentioned that every OP had a map, but with a significant variation in their properties and quality. Such maps are not useful to the extent as needed. Most commonly only straight lines are joined together in the white paper with no references or any other information. This practice has resulted in the production of less useful maps to the users. Basically there is no existence of useful maps in (OPs rather they served only the need of hand over process as demanded by the Forest By-laws, 1995. They are not useful for planning purposes and is difficult to understand. As the choice of a scale depends up on the size of the forest area and the objectives of the mapping, a wide range of scale were found to be used. Interestingly, scale is provided even in sketch maps. In general for same size of the forest the scale used varied from 1:400 to 1:10,000. On the other hand GIS based colourful map has also been included in the OP (Bakuwa CF in Ilam District) covering an area of 315 ha with a scale of 1:25,000 (in a A4 sheet). Similarly, in Dadeldhura district 14.84 ha of land area was found to be shown in 1:20,000 scale. The preparation of too big maps or too small maps reduces their uses and applicability. Bulky maps are neither handy to use or nor to attach with OPs. Smaller maps are not legible and are not informative at user level.

Surveying method

According to Acharya (2001) chain and compass is the most common method that coved 90 percent of the community forests studied. Rest of the percent was shared equally by the use of cadastral survey map and sketch map. Sketch maps were common in relatively old maps prepared up to the year 052/53. One map from Ilam district was found to be prepared using GIS. The mapping features were more severely distorted in this GIS map even compared to chain and compass survey map. For example scale was 1:25, 000 for 315 ha, no blocks can be separated. On the other hand, in some districts such as Siraha, Udayapur, use of GPS was found to survey and prepare community forestry map appropriately.

The use of Cadastral survey map does not require field surveying. Ultimately, recently encroached forest area is also included within community forest. This situation has resulted variation in the map area and field area. The legal boundary lines are as shown by the Cadastral survey map. On the other hand, in excessive encroached area people preferred for a recent boundary survey (chain and compass) to secure the encroached forest area as private property. This situation leads to the forest surveying practices where encroached area is excluded from the CF boundary. Practically a Ranger ignores the problem of forest encroachment and conducts the survey as shown by the users. In addition, it was observed that the distance interval between two survey stations was up to 1200 m in the map. In hill districts, it is not possible to be a straight-line boundary with no turns and bending of a km or more. Such mapping reflects existence of improper surveying practices and in future may invite severe boundary conflicts.

Future Requirement

61 percent out of 5.5 million ha of Nepal's forest is identified as potential community forest (Tamrakar and Nelson 1990). A total of 854,389 ha (26.5 % of potential area) have been handed over to 11,500 Forest User Groups formed until the enf of August 2002 (DoF, 2002). It took more than ten years. It shows that a huge number of CF maps has to be prepared in future for the hand over process as well as for the revision of existing Ops. To complete all potential community forest area to local users it may require to prepare about 30, 000 maps. The recent amendment in the "Community Forestry Operational Guideline, 2052" demands for the inclusion of forest inventory results in all OPs. To facilitate the process "Inventory Guidelines For Community Forest" is already been approved. Forest inventory is not possible without a good map and the guideline presumes the existence of a surveyed map in each CF. However, the field situation is opposite to this assumption. It means there could also be a need for re-surveying and mapping of almost all CF showing blocks and protection regime for the completion of forest inventory work. This situation needs to be analysed considering the manpower available in the districts, their efficiency and the existing workloads. As mentioned earlier there is a need of updating of all existing maps of community forest. A brief review of existing survey techniques and their potential is relevant. Now-a-days the use of sketch map is limited only for the reconnaissance survey and in investigation phase only.

Chain and compass survey: Although this is the most common and preferred survey method by the field staff, the heavy work load for a Ranger with the present efficiency no one can be sure of up-dating of all maps within a acceptable time. Moreover, it is less participatory and contains fewer references compared with other techniques. The compulsory inclusion of forest inventory activity, the workload for a Ranger has increased at the field. It means that the possibility of preparing a good map with this method for a large number (about 30,000) of Forest User Groups within a limited time is remote.

Cadastral survey map: This is the most cheapest and considerable efficient method of forest boundary surveying. However, the use of this in 38 districts is limited due to their quality (uncontrolled maps). In the rest of the districts, their usefulness may reduce with the needs of blocking (stratification) as demanded by the recent inventory guideline. Moreover, forestry field staffs as well as rural people are not familiar with the mapping procedure and its interpretation. This also need the incorporation of additional references and land marks to make more useful.

Orthophotos: The use of photomaps for forest boundary survey may have limited use though they are very useful to generate peoples participation. This method is also in testing phase. Application of this methods is not free from disputed and needs more clarity.

Global Positioning System: Being the recent and new technology in CF, this is the least practised method for forest boundary surveying in CF in Nepal. It is generally believed that it use is expensive and does not work in hills. The use of GPS may not be much expensive in these days even if we compare with the material cost required for chain and compass survey. It can produce map in short time. Recently, most of the Districts Forest Offices are equipped with Pentium III computers. Therefore, the potential of using GPS in forest boundary and blocking surveying in CF

should be evaluated. As it reduces the work loads of field staff, their surplus time could be used for post-formation activity, a most needed in the CF. The technical matters with GPS can be captured by Rangers as they are able to measure height and slope with recently introduced hypsometer and clinometer. Whether GPS works in hilly region or not should be verified through studies.

Conclusion and Recommendations

Forest boundary surveying is a mandatory activity for hand over process in CF. A review of 126 OPs in revealed that a map was attached in every OP studied. Most commonly such maps have only straight lines joined together in the white paper with no references or any other additional reference information. A significant variation in their properties such as survey methods, choice of a scale and forest blocking exists. Consequently the existing maps are neither useful nor informative. Virtually, there is no existence of such map in OP with required information. Future demands for the preparation of about 40,000 CF maps for the hand over process and also for the up dating of the existing OPs. To meet this target there is a need of an alternative surveying technique, which has the potential to replace, all surveying practices so far applied in CF surveying. There is a need for more discussion on the issue of forest surveying and mapping in CF. Based on the above information it can be stated that existing maps do not meet the requirements of a good map. There is a need for complete updating of existing maps. The potentiality of using GIS based techniques and combination of different existing surveying practices should explored.

Improvement of present mapping and surveying is essential. The following recommendations are listed to make forest boundary surveying and mapping more beneficial to CF. Attention should be given to find a solution which is user friendly and time efficient.

1. Irrespective of surveying methods used, maps prepared should be informative and usable. Therefore updating of existing maps is necessary.
2. There is a need of exploring the potential of using of GPS or its combination with other method. Such as combining GPS and Cadastral survey map, photomaps with Cadastral survey map, combining photomaps with the GPS, combining photomaps with chain and compass survey.
3. It will not be wise to search for a solution without considering the legal status of the techniques in our situation. As Cadastral survey map is base and Survey Department should be consulted in developing a mechanism to overcome the legal issue. The maps prepared for planning purposes alone are not useful where there is a legal case involving the private property.
4. Identification of appropriate scale for the preparation of CF map according to forest size is necessary.
5. Extension work should be given emphasis on increasing awareness and confidence of people towards surveying and mapping where land ownership receives highest social recognition.
6. The uses of GIS based technology should be cost effective. The issue of institutionalisation of service and feasibility of technically sustainability needs to be explored.

REFERENCES

Acharya, K.P. (2001) Forest Boundary Surveying in Nepal's Community Forestry, *Banko Janakari* Vol **11 (1)** 25-28.

Acharya, K. P. and M. Boer (2000) Potential of using photomaps for forest boundary survey: A comparative study. Nepal UK Community Forestry Project, Kathmandu, Nepal.

Fox, J. (1989) Diagnostic tools for social forestry. *Journal of World Forest Resource Management* Vol4 pp 61-77.

Groten, S. (1997) Aerial photographs as a means of communication in land use planning. *Agriculture + rural development*, Vol 1 pp 11-14

HMG (1995). *Forest Act 2049 (1993) and Forest Regulations, 2051 (1995), (Official Translation).* Ministry of Forests and Soil Conservation, Forestry Development Projects, Kathmandu.

HMGN (2019) *Land (Survey measurement) Act, 2019* Law Books Management Board, Kathmandu , Nepal

Jordan, G. (1998) *A report on the potential role of simple inventory techniques as part of range post planning and base line forest assessments*. Report submitted to PARDYP, ICIMOD and Nepal Australia Community Forestry Project, Kathmandu.

Keeling, S.J. (1994) The Cadastral Survey of Nepal: An Invaluable Planning Tool for Community Forestry, *Wood pecker*,

Lillesand, T.M. and R.W. Kiefer (1987) *Remote Sensing and Image Interpretation, Second Edition,* John Wiley & Sons, Inc.

Mather, R., M. Boer, M. Gurung and N. Roche (1998) Aerial Photographs and 'Photomaps' for community forestry. *Rural Development Forestry Network*, **23** e. ODI, London.

Mather, R. A. (1999) *Part III of Process Report: Evaluation of the potential for GIS based technologies to support the forest management information requirements of the FUG institution. NUKCFP*, Kathmandu.

Mather, R. A. (1998) *Part II of Process Report: Evaluation of the potential for GIS based technologies to support the forest management information requirements of the FUG institution. NUKCFP*, Kathmandu.

Mather, R. A. (1997) *Part I of Process Report: Evaluation of the potential for GIS based technologies to support the forest management information requirements of the FUG institution*. NUKCFP, Kathmandu.

Ridgway, R. (1997) Applications of large-scale aerial photographs in participatory land use planning in rural Ethiopia. *The Land* **1(1)** pp 67-74.

Seppanen, H and K.P. Acharya (1995) *Guidelines for data processing and forest mapping for the preparation of Operational Forest Management Plans in the Terai,* FMUDP Technical Report No 19, Forest Management and Utilisation Development Project, Kathmandu.

Subedi, B.L. (1993) Recommendations of the National User Group Workshop Held at Dhankuta, 31 January - 4 February 1993. *Banko Janakari* **4 (1)** pp 119-122.

Tamrakar, S.M. and Nelson, D.V. (1990). Potential Community Forestry Land in Nepal. Field document No.16. HMG/FAO/UNDP, Kathmandu.