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Author: Mather, Richard A.

Source: Mountain Research and Development, 20(2) : 154-161

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2000)020[0154:UPTSPP]2.0.CO;2

Mountain Research and Development Vol 20 No 2 May 2000: 154–161

Richard A. Mather

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Making information and decision-making processes accessible to disadvantaged and nonliterate people is a challenge for community forestry in Nepal. In studies jointly conducted by the Nepal–UK Community Forestry Project (NUKCFP) and His Majesty's Government (HMG) of Nepal Department of Forest, aerial photographs and participatory photomapping (tracing maps over aerial photographs) were evaluated with a view to supporting participatory processes of community forestry in Parbat District of the Middle Hill Region. Results indicate that, regardless of educational status, most people accurately interpreted forest condition and profiles of community use from photographs. Photographs were appreciated because they presented authentic information, allowed consistency of interpretation between groups, and made it possible to calibrate perceptions of resources. District Forest Officers and Community Forestry Officers valued aerial photographs as robust instruments that naturally directed discussions toward community and resource issues. Results of a pilot study of the use of aerial images for surveys indicated that orthorectified aerial images may substantially reduce time spent by District Forest Office (DFO) staff in chain-and-compass surveys of community forests. Surveys based on aerial images encourage the participation of users, and boundaries drawn over survey photomaps are represented in the context of important reference information contained in the photographic image. The development of a service for low-cost printing of high-resolution and geographically correct photomaps is described.

Keywords: *Photomapping; community forestry; participatory approach; Parbat District; Nepal.*

Peer-reviewed: *October 1999.* ***Accepted:*** *February 2000.*

Introduction

The Community and Private Forestry Program has top priority in the Master Plan for the Forestry Sector of Nepal (HMG-Nepal Ministry of Forest and Environment 1990). The main focus of this program is the handing over of all accessible hill forests for management by local communities (Shrestha et al 1995). At the heart of this process is the formation and recognition of forest user groups (FUGs) that have legal responsibility for managing forests and entitlement to all benefits produced from the forest.

Maps and mapping processes are widely used to foster the empowerment of local communities (Foster Brown et al 1995; Jarvis and MacLean Stearman 1995) and are highly valued in participatory rural appraisal (PRA) for exploring community–resource interactions (Lamb 1993; Jackson et al 1994; Messerschmidt 1995; Poole 1995; Carter 1996). Participatory maps based only on community perceptions, however, have certain limitations, including their lack of reliability as a means for establishing the scale of areas (the size of features is often portrayed to reflect subjective importance rather than physical scale) or as a means of determining boundary information (Carter 1996). Scale, however, may be provided if sketch maps are based on copies of topographic maps (Fox 1990). Limitations may also arise with respect to the balance of representation within groups due to the influence of education and social environment on individual ability or willingness to participate. Even when expertly facilitated, all participatory methods are vulnerable to distortion and inequality.

Successful examples of the application of aerial photographs to participatory land-use planning in hillside environments have been reported for Ethiopia (Ridgway 1997) and for northern Thailand (Tan Kim Yong 1992). Several years earlier, Carson (1987) clearly demonstrated the value of aerial photography for determining land utilization, rates of erosion, village infrastructure, and land management in Nepal. Aerial photographs also provide historical baseline data for monitoring changes in land use and/or forest condition (Schweik et al 1997; Jackson et al 1998) and for recording tree cover on farmland (Carter and Gilmour 1989; Gilmour and Nurse 1991). Workers, however, also report limitations in using smaller scale photographic enlargements (generally less than 1:5000) and difficulties in obtaining large-scale images (Jackson et al 1994; Jackson and Ingles 1995; Keeling 1996). By contrast, Carson (1987) concludes that 1:5000 enlargements "...provide an ideal base for the rapid appraisal of village resources in the Middle Mountains of Nepal."

Evaluating photomapping in Parbat District, Nepal

The availability of up-to-date and high-quality 1:50,000 aerial photographs for Parbat District in Nepal, coupled with recent improvements in image-processing and image management technologies, provided an opportunity for evaluating the usefulness of aerial photographs and practices of photomapping on transparency to support participatory processes of community forestry. Field evaluations were conducted to verify their usefulness as a means of providing more equitable access to information and of forming a common basis for under-

standing and interpreting the condition of forest resources and community profiles. Examples of information comprising community profiles included the identification of forest users, their households and village ward affiliations, as well as their socioeconomic status, caste, gender, and interest in and access to resources. The working hypotheses of studies reported here are that, when presented with authentic and reliable visual information about their resources, forest users are more inclined to take active roles in decision-making and, by using such approaches, facilitators of community forestry processes and forest users are able to develop a clearer understanding of the community profile in the context of resource use.

Methodology

As part of the aim of evaluating aerial photographs as a nonliterate tool for participatory work, the specific objectives were to determine their usefulness for

- Stimulating discussion among villagers.
- Recognizing and interpreting immediate surroundings.
- Encouraging greater participation and more equitable representation of the views of nonliterate individuals, women, and marginalized groups.
- Providing a base over which participatory maps could be drawn.
- Transferring information from one group to another.

Parbat District was surveyed by air in late 1996 for the HMG-Nepal Department of Survey topographic survey of western Nepal. Photographic enlargements were made from high quality 1:50,000 panchromatic contact prints and from a diapositive (positive transparency). Scales of reproduction were between 1:5000 and 1:1250, representing magnifications of 10 and 40 times, respectively.

The principal field evaluations involved 12 participatory sessions held during May and June 1997 at two forest sites (Thulosalgari and Akhori Pakho forests) where users had applied for FUG status. Each group session was observed by a Community Forestry Officer (CFO), a Forest Ranger, a Forest Guard, a volunteer worker, and a research worker. For purposes of consistency, the field team endeavored to replicate certain aspects of location and stages of participatory sessions using a semistructured approach to the survey. This approach followed established principles of iterative revision of questions/hypotheses and triangulation between sites (Grandstaff and Grandstaff 1987; Fox 1990; Swiss Directorate for Development Cooperation and Humanitarian Aid 1993; Food and Agriculture Organization of the United Nations 1994; Messerschmidt 1995). A typical discussion between a group of villagers and members of the interdisciplinary observation team comprised the following sequence of events:

1. The Forest Ranger and Forest Guard would arrange a meeting, usually at one of the stone resting platforms known as *chautaara*.
2. If earlier groups had produced paper participatory maps or maps on transparencies over photographs, these were presented for study and comment by the current group.
3. Both the small-scale photograph enlargement of the north of Parbat District and large-scale aerial photographs of the specific forest area and immediate village surroundings were introduced to groups.
4. A conventional participatory map was produced with color marker pens on brown paper, and/or
5. Using a transparent plastic overlay, participants would draw participatory photomaps by marking boundary and other information on transparent acetate placed over either a 1:1250 or a 1:2500 enlargement.

Results and discussion

Participatory use of aerial photographs

Aerial photographs were found to be a catalyst for discussion and were comprehensible to nearly all people regardless of educational background. They also provided a means for calibrating and encouraging consensus in perceptions of surroundings among forest users. Throughout the entire field exercise, clear themes emerged that consistently recurred among the observations recorded during the 12 participatory sessions (summarized in Tables 1 and 2). Perhaps the most important findings were that educated and nonliterate people appeared to be equally adept at interpreting aerial photographs. Those individuals who had the closest contacts with forests and the land (often representing disadvantaged target groups such as women and the landless poor) were most astute in their appreciation of more subtle qualities of the images and were able to interpret finer details of forest conditions. Findings with respect to the specific objectives set for evaluating aerial photographs were as follows.

Stimulating discussion: The aerial photographs were effective ice-breakers and engaged the immediate attention of all present. Discussions were naturally directed toward issues implied by information on aerial photographs. Some of the field team observed that women and poorer people who were sometimes reluctant to enter a public discussion became less self-conscious, possibly due to their confidence and an absorbing interest in the photographic medium.

TABLE 1 Summary observations from meetings at Thulosalgari Forest.

Group and composition	Photo interpretation	Resource issues
(1) Pakuwa VDC Ward 7; 34 men, 8 women, many children	Intense interest and complete absorption in photos Interpretation begins with linear features (rivers and roads), then houses and the *chautaara* where we are meeting	Some forest protection where grazing banned Women as key forest users are interested in forming FUGs
(2) Pakuwa VDC Ward 6; 9 men, some children	As recorded for group 1	Issues are dispute over rights to gather grass from forest, uncertainty over position of forest boundaries, women are more interested in forming FUGs
(3) Pakuwa VDC Ward 6; 9 women, 5 children	Generally as recorded for groups 1 and 2	Some of group excluded from another area of community forest Poor regeneration of forest attributed to uncontrolled grazing
(4) Pakuwa VDC Ward 9; 22 men, 8 women, 6 children	Generally as recorded for the earlier groups	Group manages some community forest of pine for timber and hardwood coppice for fodder
(5) Pakuwa VDC Ward 8; 13 men, 1 woman	Slow interpretation possibly due to few local landmarks on photos and poor view of surroundings	Opinion is that Wards 6, 7, and 8 should have access to the forest and that Ward 9 is too far away to be included
(6) Tilhar VDC Wards 1–3; 9 men, 3 women	Good views of forest from elevated position Interpretation progresses at a brisk pace	Ward 3 members are upset at not having been consulted when Ward 4 requested that the forest be handed over
(7) Tilhar VDC Ward 1; 5 women, many children	Despite absence of views, photointerpretation by children is good	Women here identify areas of *kharbari* (grassland) encroachment

TABLE 2 Summary observations from meetings at Akhori Pakho Forest.

Group and composition	Photo interpretation	Resource issues
(1) Pipul Tari VDC Ward 9; 15 men	Interest and process of recognition is as recorded in Table 1	The position of the VDC boundary dividing forest between Pipul Tari VDC and Thuli Pokhari VDC is disputed
(2) Pipul Tari VDC Ward 9; 5 women	Great interest in photos but interpretation interrupted when a man is invited to show the women how to complete their map!	Due to interruption, resource issues are not discussed
(3) Tuli Pokhari VDC; 9 men, 2 women	One man quickly identifies principal rivers, landscape features, and 5 pine trees he planted 15 years earlier	The disputed VDC boundary and an area of illegal clear felling converted to cultivation
(4) Pipul Tari VDC Wards 6–8; 29 men	A large and busy group that interprets the photos with ease	Many present are landless, poor, nonliterate, and wish to have greater use of the forest
(5) Pipul Tari VDC Wards 6–8; 5 women, 3 men	In 15 minutes, women identify all main features	Women are reluctant to draw forest blocks for Pipul Tari VDC as they think this may be a binding declaration; they were not consulted about division of forest

Interpretation: Interpretation normally proceeded with recognition of linear features such as rivers, roads, and trails. Forests were identified, and on the larger scale enlargements, houses, schools, fields, and the location of the *chautaara* were quickly recognized. Possibly as a result of lifelong familiarity with hillside landscape views from an oblique perspective, people were very adept at photointerpretation. It was noted, however, that the process of interpretation was accelerated when familiar landmarks were present. Forest users were particularly anxious to see their houses on photographs. The only limitation recorded was that a few individuals with poor sight had difficulty with interpretation.

Participation: The photographic medium was effective in engaging women and socially disadvantaged individuals in discussions. In comparison to conventional practices of participatory mapping, which rely heavily on the facilitator to direct discussions, resource issues visually evident on aerial photographs had the spontaneous effect of stimulating discussions that then progressed to related community matters. In one group, women were quick to recognize the openness of tree canopy in a part of the forest and attributed this to unrestricted grazing over which they had no control. Other groups identified illegal farming of supposedly shared forest resources and conflicts over boundaries and land use. In all sessions, groups were able to describe the division and use of forests.

Use of aerial photographs as a base for participatory mapping: Without common reference points, spatial perceptions of a landscape vary from person to person. This was particularly evident when comparing conventional participatory maps produced by different groups for the same forest area. Aerial photographs, however, provide an accurate standard by which forest users can calibrate spatial and qualitative perceptions of the landscape. On many occasions, individuals said that they appreciated the enlargements because they were "real." Due to the authenticity, reliability, and spatial accuracy of information portrayed, people were more trusting of participatory processes.

Transferring information from one group to another: In comparison to paper participatory maps, those based on photographic information and participatory photomaps were interpreted consistently by all groups.

Community profiles and resource use

Much of the information required for developing community profiles and consensus among users was already present on photographs, including the position of settlements, forest area, and forest condition. Photographs therefore provided a focus for discussing the present use of resources, associated issues (problems and conflicts), and user expectations following the handing over of forests. The information presented was also very useful given the circumstances of DFO staff who, due to the size, diversity, and geographical relief of Middle Hill command areas as well as the frequent transfer of staff, very rarely have the opportunity to visit all settlements and forests within a range post.

Site 1, Thulosalgari Ban (Forest): Users of this natural forest of approximately 165 ha were found to be Wards 6, 7, 8, and 9 of Pakuwa Village Development Committee (VDC) and Wards 1, 2, and 3 of Tilhar VDC. The pattern of forest use by Pakuwa wards perceived by the community was clarified by superimposing boundary and area information from participatory photomaps drawn during group discussions. The villagers of Tilhar VDC referred to aerial photographs to describe the boundaries for forest use in great detail. Villagers identified many unregistered *kharbari* (grass-producing) sites on the aerial photographs, most of which were within the main forest area. The illegal "owners" of these sites were understandably reluctant to see them included in any community forest agreements. Users without *kharbari,* however, were strongly of the opinion that they should also benefit from what was a potential community resource, and they were particularly keen to begin the handing over process.

Site 2, Akhori Pakho Forest: Akhori Pakho is a natural forest of approximately 110 ha forming a west–east band along a steep-sided ridge (Figure 1A). The traditional users and potential FUGs were identified as members of Pipul Tari VDC in the west and Tuli Pokhari in the east. The main resource issues emerging from participatory discussion and mapping sessions (Figure 1B) were

1. A dispute concerning the exact position of the boundary between Pipul Tari and Tuli Pokhari VDC inside the forest area.
2. Illegal conversion of forest to farmland.
3. Exclusion of some poorer groups from consultations relating to the division of the western half of the forest into eight blocks and poor consensus relating to the exact positions of block boundaries (also reflected in Figure 1).
4. Gyandi Range Post's opposition to a request from some members of Pipul Tari VDC that the west part of the forest be divided into eight separate community forests.
5. A dispute arising from members of Ward 8 of Pipul Tari VDC applying to be recognized as legal users of forest in the area of Tuli Pokhari VDC, this being strongly opposed by the latter VDC.

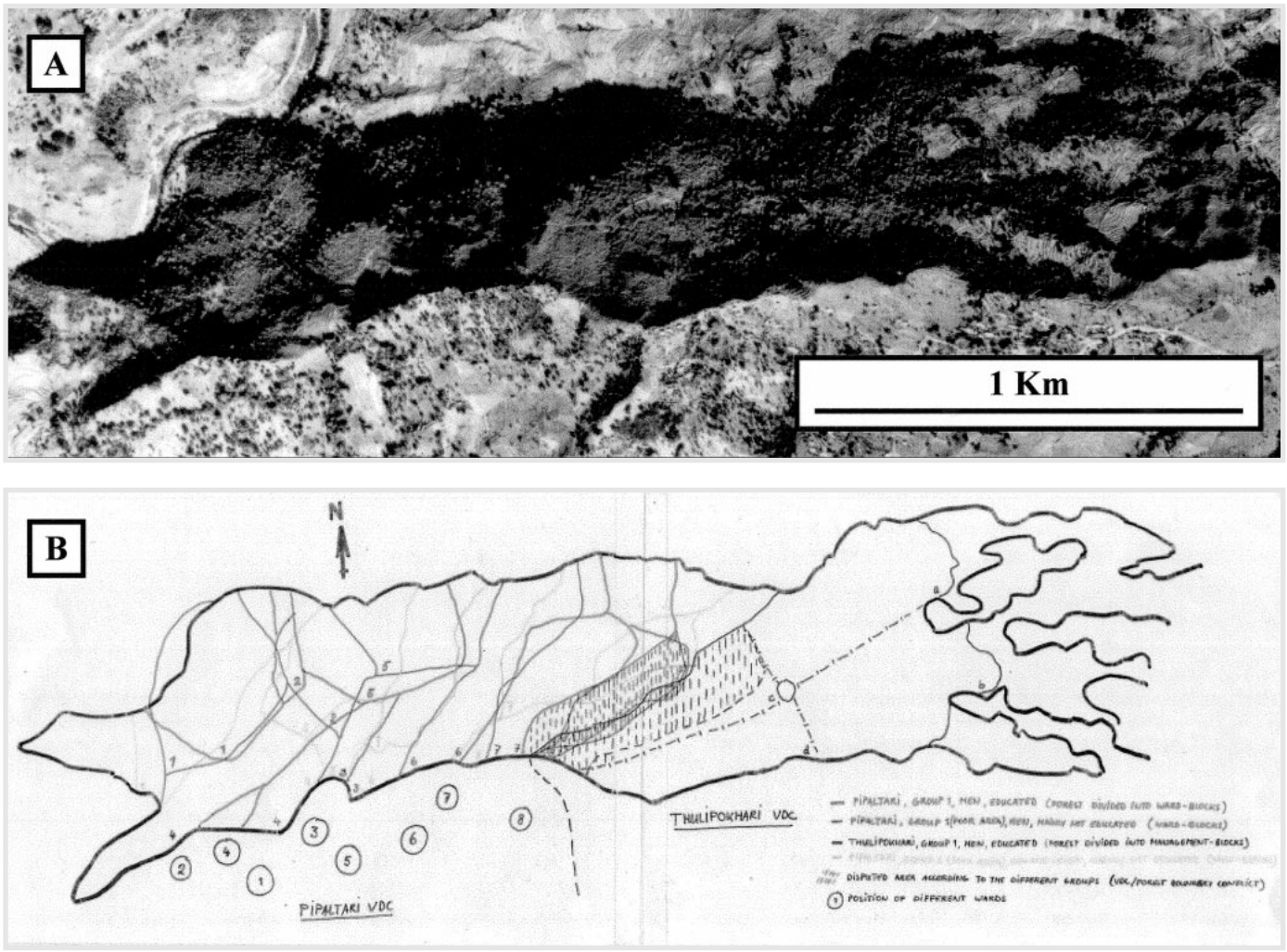


FIGURE 1 Aerial photograph (A) and sketch of superimposed participatory photomaps of Akhori Pakho forest (B). Information from participatory photomaps (traced over aerial photograph enlargements) is superimposed in B. On the original of this black-and-white reproduction, color lines corresponded to sketch maps made by groups 1, 3, 4, and 5 in Table 2. Numbers in circles are positions of Pipul Tari VDC (spelled Pipaltari) wards. Colored shading (shown here as hatched) indicates disputed area surrounding the boundary between Pipul Tari and Tuli Pokhari VDC (spelled Thulipokhari) as perceived by groups 1, 3, and 4. Issues identified included the poor correspondence of boundaries dividing 8 blocks of forest between the 8 wards of Pipul Tari VDC and the disputed area arising from an application by Pipul Tari Ward 8 to be recognized as users of forest in Tuli Pokhari VDC. (Aerial photo by FINMAP; composite sketch map by Martin de Boer)

Issue 5, initially misinterpreted as a conflict over the position of the VDC boundary, was only fully understood after field visits to Akhori Pakho had taken place and when information produced in four participatory photomap sessions was superimposed and summarized on a single acetate transparency (Figure 1). At the time of writing, the case still awaits court attention to resolve the conflict between the two VDCs. Range Post workers, however, were of the opinion that, by clarifying issues through aerial photograph interpretation and mapping, an important step had been made in the process of handing over the forests.

Aerial photographs and GIS as tools for forest survey

The results from a pilot study indicate that participatory boundary surveys of community forests based on aerial photographs may offer an alternative to the chain-and-compass surveys conducted by DFO staff (Mather 1998). Survey maps are required for the preparation of community forest operational plans, that is, legal agreements between FGOs and His Majesty's Government of Nepal. Apart from the difficulties of accurately surveying forests on steep slopes, other limitations of chain-and-compass surveys are

- Time spent in survey substantially reduces DFO time for participatory work.
- In comparison with boundaries marked over aerial images, chain-and-compass survey maps convey little additional reference information.
- As a less participatory means of survey than photomaps, chain-and-compass surveys may leave users with a reduced sense of owning the operational plan.

In the pilot study (Mather 1998), boundaries of four established community forests were drawn on aerial photographs, three with the participation of forest users facilitated by Range Post staff and one conducted as a desk exercise with Range Post staff. The photographs and superimposed boundaries were scanned and the resulting digital images geometrically restored to UTM grid coordinates on a GIS. The GIS was used to calculate forest areas. The system may also be used to make printed copies of the geographically corrected image with superimposed boundary, grid, and scale information. Copies can be included in the operational plan and can be provided to forest users for their reference. Results of a comparison between chain-and-compass and aerial-photograph/GIS survey (summary in Table 3) indicate (1) that, for 3 forests, significantly greater areas were recorded by chain-and-compass survey and (2) that compass surveys were more time consuming. For the GIS surveys, an allowance was made of 1 day for participatory mapping of boundaries on aerial photographs and 1/2 day to complete GIS work.

There are many possible reasons for the differences in areas recorded by the two surveys, including difficulties obtaining planimetric measurements by chain-and-compass in hilly terrain, incorrect marking of boundaries on aerial photographs, and other errors associated with either form of survey. It is very unlikely that such large differences (the area recorded by chain-and-compass for Pakuwa Das being 42% greater than that recorded by GIS) would have resulted from comparatively small errors associated with restoring aerial images to UTM coordinates. Reliably establishing causes of discrepancies would require an in-depth study of potential sources of error, including the positional accuracy of survey methods and possible differences in perceptions concerning the positions of forest boundaries.

Early indications are that aerial photograph images geometrically restored by GIS have considerable potential for meeting the survey needs of community forestry. Among the potential benefits are a substantial reduction in the time spent by DFO staff in chain-and-compass survey and provision of a means for a more meaningful participatory survey, thereby reducing post-FUG formation conflicts.

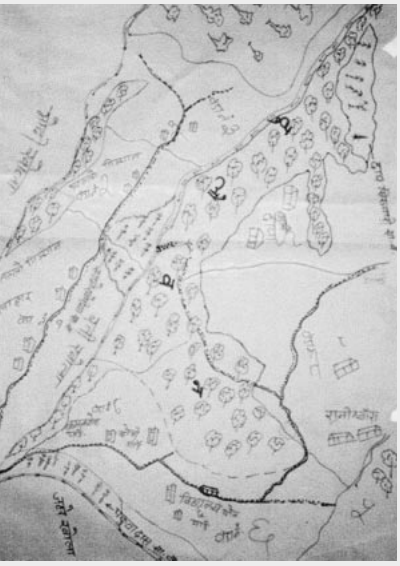
Developing a photomap service for Parbat District

After establishing the usefulness of aerial images in field tests, the next challenge is to develop technical systems and institutional capacity for delivering map-corrected images to forest users and institutions facilitating community forestry processes. An image database for photomap systems was developed by digitally scanning 1:50,000 diapositives at high resolution. Distortions of perspective were removed and geographic correction restored by orthorectifying digital images to UTM Everest Grid ground control coordinates obtained from 1:25,000 topographic maps. Individual images from each scan were contrast corrected and color balanced, then integrated in a database so that they could be viewed and managed as a single seamless mosaic of aerial photomap cover. The final product is a digital photomap coverage at an image-pixel to ground resolution of 1 m^2. The seamless mosaic database of the computer software used, "Map Maker Aerial©,"

TABLE 3 Comparison of area recorded and time taken for survey by chain-and-compass and aerial photograph/GIS survey.

Community forest	Area recorded by compass survey (ha)	Area recorded by GIS (ha)	Days required for compass survey (est.)	Days for GIS survey including field survey	Comments about GIS survey
Chhamarke Patal	83.1	76.1	10	1.5	"Desk" survey by RP staff
Pakuwa Das	6.7	4.7	2	1.5	Field survey with RP staff and users
Bhadkore	57.5	51.9	8	1.5	"Desk" survey by FUG
Dhaireni Sutlamare	36.8	37.9	10	1.5	Field survey with RP staff and users

FIGURE 2 Field evaluation of aerial photographs, participatory sketch maps, and photomaps. (Photos by author)



A participatory sketch map of Thulosalgari forest produced by the men and women of Pakuwa VDC Ward 8.

Most discussions, aerial photographic interpretation, and mapping sessions were conducted at stone platforms known as *chautaara*.

Members of Pakuwa VDC Ward 7 produce a participatory photomap for Thulosalgari Forest.

A group of women from Pakuwa VDC Ward 6 use a large-scale photographic enlargement to discuss the use of Thulosalgari forest and the impacts of grazing on forest condition.

Men and women from Wards 6, 7, and 8 of Pipul Tari VDC use a very large-scale enlargement (1:1250) to identify users and usage of Akhori Pakho Forest.

allows system operators to treat all the many fragments of image as if they were a single photomap. Other advanced features of the photomap system include automatic image-database management/compression with automated map scaling and map formatting and compatibility with ArcView© vector formats and overall ease of system use.

As a result of automating many conventional GIS procedures, the system requires no training beyond general familiarity with working in the Microsoft Windows computer operating environment. The photomap service for Parbat District is therefore based on a very user-friendly computing system by which operators may print geographically correct photomaps on inkjet printers at any scale requested up to a size of A2 and at low cost compared with conventional means of photographic reproduction.

At the time of writing, digital photomaps were available for 7 districts, and HMG-Nepal Department of Forest were considering expansion to many other districts. Indications are that systems for production and distribution may be maintained using existing line agencies and facilities and with minimal support from development bodies. Perhaps the greatest challenge remaining is to make services genuinely accessible to the FUG institution, forest users, and all facilitators of community forestry processes.

Conclusions

Without a clear understanding of existing management and the expectations of the various groups of forest users, there is considerable potential for the official handing over of community forests to accidentally exclude vulnerable people from forests and to exacerbate conflicts. The single most important finding, therefore, was that aerial

photographs made information, issues surrounding forest management, and participatory processes more accessible to nonliterate people. Experiences from field evaluations (Figure 2) indicate that the photographic presentation of physical information was relatively indisputable and reliable in the view of participants. Such authenticity of information engenders a greater sense of trust and confidence among stakeholders, and it was apparent that, by using aerial photographs, the District Forest Office staff had also developed a greater understanding of the community and user profiles surrounding Thulosalgari and Akhori Pakho Forests.

Apart from potential benefits to survey technique and procedure, the survey use of aerial images has similarly promising participatory qualities. Opportunities to engage users in surveys so that boundaries are walked and clearly marked on a survey photomap in the context of the landscape produce a more meaningful survey product than the chain-and-compass line maps and reduce the likelihood of post-FUG-formation conflicts.

Results obtained to date support the working hypotheses that aerial images encourage more active roles in discussions relevant to decisions made by FUGs and contribute to both user and facilitator understanding of community profiles in the context of resource use.

AUTHOR

Richard A. Mather
Forest Products Research Centre, Buckinghamshire Chilterns University College, Queen Alexandra Road, High Wycombe, Buckinghamshire HP11 2JZ, UK. rmather@hotmail.com

ACKNOWLEDGMENTS

The studies and observations reported represent the combined efforts of the District Forest Office, Range Posts, and communities of Parbat District working alongside the Nepal-UK Community Forestry Project. This paper is based on an earlier publication by the Overseas Development Institute (Mather et al 1998).

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