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Does Community Involvement Matter? How Collective Choice Affects Forests in Mexico.

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Does Community Involvement Matter? How Collective Choice Affects Forests in Mexico*

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Abstract

Current natural resource policy emphasizes devolved control to local levels of government and stakeholder groups. Effective strategies are as yet unclear, given mixed results in devolutionary efforts and few empirical analyses. Using original community-level survey data from Oaxaca, Mexico, a region with 90% common property forestland, the study describes how existing community governance structures accommodate an increasing local role in managing forest land. Multidimensional performance indicators for forest condition and group rule conformance are constructed and regressed on measures of democratic involvement and attendance rate at general meetings within the community setting. Empirical results show that community officials and foresters working through broader-reaching forums for disseminating information and seeking management plan approval improves both performance indicators, while attendance rate additionally leads to greater rule conformance. Results imply that the nature and conduit of community involvement matters in encouraging cooperation with management objectives and give a further understanding of how devolution policies can be applied in complex institutional settings. JEL Classification: O17, Q23.

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1 Introduction

The recent trend towards devolution of natural resource management has brought the challenges of collective decisionmaking over environmental resources to the fore (Little 1994, Agrawal 2002, Ribot 2002, Brockett and Gottfried 2002, Kumar 2002). With devolution, governments allow local resource stakeholders to participate more fully in shaping rules of access, maintenance and allocation of public or common property resources. Its success or failure affects a significant amount of resources – one FAO study claims at least 50 countries have adopted some form of devolutionary resource management strategy (Agrawal 2002). Among the challenges are problems of collective choice, such as elite control, exclusions of segments of the population and a tendency towards individual noncooperation over common pool resources, known as the "tragedy of the commons" that leads to resource overexploitation. However, few studies examine the complex processes of local decisionmaking and link measures of stakeholder involvement to performance indicators. This paper focuses on the broadness of stakeholders' involvement in forums designed to exchange information concerning timber production activities, overall management goals and expectations of local stakeholders regarding use of their communal forest resource. It operationalizes the concept of participation and, consequently, access to forest production and management information across a sample of Mexican agrarian communities to determine how such access affects group conformance to management rules and quality of the forest resource. We show that information shared broadly through democratic forums reflects a more complete scope of participation in decisionmaking which elicits cooperative behavior and results in higher institutional performance.

The benefits of information exchange of both a technical nature and others' actions underlies the prescription of participatory management approaches. The use of common property resources takes place in often uncertain environments so that stakeholders with more information can use the resource and build management institutions more effectively (Lam 1998, Ostrom 1990). The management of public goods and common property resources depends also on a diverse set of individuals, so that knowledge of other's actions becomes part of one's decisions. Access to the medium of information exchange and the ability to act on that information generally improve the outcome. The quality of *de facto* over *de jure* participation in development

projects (Hoddinott et al. 2001) and the exclusion of women and the less wealthy or politically powerful from resource management decisions (Agarwal 2001, Sundar 2001) have been associated with project outcomes and income distribution. The emphasis on devolution in recent years also coincides with studies which call for integrating local indigenous knowledge with professional expertise to adopt conservation programs using adaptive management approaches, achieve productive efficiency and reach economic development goals (Klooster 2002b, Berkes, Folke and Colding 1998, Robbins 2000).

One of the most consistent findings in the experimental economic literature on common pool resources is that discussion among stakeholders increases the likelihood that they will cooperate, as defined in the experiment and consequently enables them to reach higher levels of return (Kopelman, Weber and Messick 2002, Bardhan 1993, Ostrom et al. 1994, Baland and Platteau 1996). These results have undermined the characterization of the commons as a one-shot prisoners' dilemma game in which the only equilibria is the noncooperative outcome. Even where choices are confidential and, therefore, nonbinding, communication increases cooperation. Leading explanations for why communication promotes cooperation are that it permits coordination of an optimal joint strategy, builds trust, enhances group identity, reduces egocentrism, exposes individuals to verbal criticisms for infractions, and allows people to elicit commitments to cooperate. Evidence tends to favor the elicitation of commitments to cooperate, as well as building trust and delivering verbal criticism (Kopelman et al. 2002, Ostrom et al. 1994, Ostrom 2002) as experiments have found that people may follow up on their commitments even with anonymous promises because of self-monitoring or an internal personal norm against violating a commitment.

A key element is the nature of the forums that allow communication among stakeholders. In experimental studies, variations in communication matter. One-way communication is "better" than no communication but two-way communication has an even stronger positive influence on cooperation. In real-life settings, any organizational structure will influence the interaction of participants (Zusman and Rausser 1994). For example, voting can act like a communication device when no other communication is possible, as the voting process offers an opportunity for learning (Kopelman et al. 2002). The performance of governing bodies has been analyzed in terms of frequency of meetings, participation rates, preparation for decisions and methods of reporting to members (Zusman 1988). This does not suggest that all decisions must be made in open

forums to achieve management goals. Generally, it is observed that decisions are allocated to the forum that minimizes decision costs relative to its importance to individual members (Zusman 1992, Ostrom 1990, Zusman 1988, Vermillion 2001, Buchanan and Tullock 1962). For example, decisions with less impact on group members are often delegated to a management team while decisions with broad and direct impact are made by the entire membership.

Despite its importance, few studies empirically explore forums for information exchange in common property management. In this paper, we complement a contextual description of a common property forest governance system with empirical analysis relating qualities of information channels concerning the resource to performance indicators. The research setting is the Mexican agrarian communities with timber production in which some level of forestry management guidelines have been developed. These communities are characterized by a local and state-recognized political structure for making decisions on communal land with forest holdings. Forestry ranges from individual harvesting of timber and nontimber products to sophisticated milling and management activities, both of which fall under the purview of community-appointed officials. There are two information flows that we think are important: intracommunity exchange of information and exchanges between the professional forester and the community about technical matters. The forester can interact broadly with the community in the General Assembly, a governing body open to all members of the community, or in smaller sessions with appointed officials. Attendance rates at General Assembly meetings also vary. The research question is whether collective decisionmaking characteristics representing information channels affect performance indicators by encouraging cooperation with group objectives.

With data from a sample of 44 Mexican communities or work groups involved in timber production, we develop ecological performance indicators and analyze their empirical relationship to the quality of communication channels. We focus on two performance indicators: rule conformance and ecological status of the forest. We hypothesize that broadly communicated through the community's General Assembly and where attendance rates are high, information may be captured by the local membership, leading to higher performance ratings. An econometric analysis using ordinary least squares and instrumental variables largely bears out these arguments. We find that the use of locally accepted democratic forums for disseminating technical information strongly affects the ability of the community to support management goals and quality of the

forest resource and that higher attendance rates lead to higher rule conformance. The performance indicators are conditioned on other noninstitutional variables as well, which have explanatory power. As such, this research complements work emphasizing the need to address both sociodemographic and physio-geographic characteristics for determining deforestation patterns and provides a much more detailed study of resource use patterns (e.g. see Deininger and Minten (2002)). While these findings generally support the rationale of the devolutionary policies, the research highlights the particular nuances of local stakeholder involvement that would affect the strategies taken.

The paper is outlined as follows. Section 2 describes Mexico's forest resource, the institutional setting of the community forestry sector, data collection, key summary statistics, collective decisionmaking characteristics of communities in the sample, and measurement of forestry management indicators. The econometric analysis and results are presented in Section 3, followed by a conclusion in Section 4.

2 Mexican forestry and communal land tenure

2.1 The forest resource

About a quarter of Mexico's land area is covered with closed canopy forest, half tropical and half temperate forests (Klooster and Masera 2000). The forests support diverse ecosystems, evidenced by Mexico's ranking of fourth in the world in biodiversity (IBRD 1995). At the same time, estimated rates of deforestation range from 0.8% to 2% a year (Klooster and Masera 2000), depending on forest type and estimation methodology. The main causes of deforestation in the temperate forests in order of importance are human-induced forest fires, livestock production, timber extraction and agricultural production while cattle ranching tops the list in tropical forests (IBRD 1995). Deforestation is both an outcome of and a cause for other ecological processes, as forest degradation precedes clearing of forest land and deforestation creates conditions for soil erosion. As a result, Mexican forest policy today has received international support in creating strategies to conserve forests and control its exploitation (IBRD 1995, CONAFOR 2001).

Oaxaca, a southern state in Mexico where this research is based, features prominently in representing Mexico's forest resources. Half the floral species in Mexico can be found in Oaxaca, including a wide

variety of cacti, orchids, pine and oak species. While its forests are mainly temperate pine-oak forests, it also hosts tropical forests with cedar, mahogany and common tropical tree species, and the unique cloud forests ecosystems. Oaxaca has the highest count of mammalian species in the country, many of which are concentrated in forests, including endangered species of tapirs, white-tailed deer, foxes, and felines (SEMARNAT 2002).

2.2 Land tenure, governance and forestry

Mexico's land tenure patterns pose an interesting case for common property scholarship in that agrarian communities have a state-recognized corporate structure, defined territorial boundaries and usufructory rights over communal land. The communities, known as *ejidos* and *comunidades*, derive their legal basis from Article 27 of the 1917 Constitution created subsequent to the Mexican Revolution and which sought to redistribute or repatriate large land-holdings concentrated under the *hacienda* system to peasant populations. Individuals claiming land under this system are connected through membership in a community which holds title to the land. In most communities, the system falls short of complete private property. Technically, all land in a community is communally-managed property. Individuals members are given the right to plots of land for agriculture, livestock and dwellings but do not hold title to the land nor are able to sell the land outside the community unless the community has voted to privatize all individual plots, as provided by the Agrarian Reform of 1992. This action has been mainly limited to urban *ejidos* (Goldring 1998). Designated forest land is managed as common property for access by all members and is to revert to the state if privatized under the reform laws (Bray and Wexler 1996).

While the organizational structure is codified in Article 27, customs of voting and election to office are thought to date back to precolonial traditions and may diverge from the national party voting system. Many *comunidades* practice a system of rotating civic and religious responsibilities among registered community members based on accumulated merit in a rising hierarchy of civic positions (Carlsen 1999). The traditional system of *cargos* and more generally the practice of *Usos y Costumbres* tends to hold stronger among the *comunidades* which have historical claim to the land, as compared with *ejidos* which represent land grants to groups of previously landless peasants. In states with a strong indigenous population like Oaxaca, *Usos y*

Costumbres, remains widespread, and in 1998, the State of Oaxaca formally accepted *Usos y Costumbres* as an official alternative to the national electoral process, although heads of a municipality must claim a party once elected (EDUCA 2001). Votes on major decisions affecting the community are taken in the General Assembly, the supreme governing body which decides on all principal issues of the community and in which each registered member of the community, called a *comunero* or *ejidatario*, has one vote. Voting is by consensus or majority rule, depending on community practices. Elections to office are held approximately every three years. These offices range from the president of the municipality, patrols, messengers, and in some places, to the *mayordomo* of community religious festivities. Common property management responsibilities fall to the *Comisariado de Bienes Comunales* (CBC) or *Ejidales*, the civic office charged with attending to land issues within the community. The CBC is the community's representative in internal disputes or interactions with government and other communities on land issues. A vigilance office, called the *Consejo de Vigilancia*, patrols the communal resources and acts as a check to the CBC. These offices can be unsalaried, unspecialized towards forestry or any other management skill, and subject to the approximately three-year rotation term. Assemblies meet a minimum number of times per year as required by law. In addition, extraordinary meetings are called to discuss issues that need immediate community attention.

The implications for Mexico's forestry policy cannot be understated as approximately 80% of national forest resources are held by 8000 *ejidos* or *comunidades* (White and Martin 2002, Snook 1997). The state maintained and exercised the right to lease community forest land to private and semi-private firms up until 1982, when policy shifted to a more community-based approach (Klooster 2002a). In 1986, the Mexican government formally recognized the rights of agrarian communities to commercialize their timber resources (Bray and Wexler 1996). In many places in Mexico, a "community forestry sector" has replaced parastatal and peripheral private harvesters. Since the liberalization of community forestry policy, patterns of accessing the forest have shifted from individual harvesting of forest products for domestic consumption and occasional sale to commercializing timber production collectively (Cabarle et al. 1997, Antinori 2000, Antinori and Rausser 2000).

With devolved community-level control over forestry, community governance structure has adapted with more specialized organizations capable of addressing forestry management and timber production. The exist-

ing system has absorbed its new economic role under the oversight of the CBC but with high organizational variability across communities. The CBC may be directly responsible for managing timber production activities or, in communities with more advanced processing capabilities, the community may form a *unidad* or *sociedad* that has legal standing as a production unit. Each individual member of the community is a *socio*, the term for a part-owner, partner, or shareholder in a labor-managed firm, yet shares are not defined nor traded. The CBC may appoint additional personnel to manage these community forestry enterprises, such as a general manager, chief of sales, logging foreman, or sawmill manager, as needed. Due to conflicts or historical idiosyncrasies, subgroups within the community will occasionally form, with each group claiming a portion of communal forest lands and appointing separate management teams, which may include separate CBCs. Some communities have begun to pay the CBC a salary.

The technical services of a professional forester are integral to community timber production. Harvesting timber for commercial purposes requires a management plan prepared by a qualified forester and approved by the Ministry of Environmental and Natural Resources known by its Spanish acronym, SEMARNAT. Foresters are primarily responsible for preparing the plan and providing the necessary documentation for its approval and directing silvicultural treatments. Once provided by the government or by companies leasing community forests, today professional forestry services are privatized, and producers, either the communities or private firms, must contract a professional forester. Many management plans today apply the *Metodo de Desarollo Silvicola*, that establishes a system of even-aged stands with seed-tree regeneration. This system is now favored over the *Metodo Mexicano de Ordenación de Montes* method that permitted less intensive cuts but tended to impoverish the genetic strength and composition of Oaxaca's pine-oak forests (Snook 1997).

Unless there is specific delegation otherwise, the forester's point of contact in the community is the CBC. Beyond the basic services, the forester-community relationship varies widely. The forester can provide technical training or hire locally for marking trees, inventory assessment or treatments, act as a liaison with the private sector in seeking markets and financing for projects and attend Assembly meetings where forestry matters are discussed to provide input on technical matters and present options available to the community.

Despite the officially democratic structure of Mexican communities, participation in decisionmaking also varies, with consequences for forest management. In one study of a Oaxacan community with forest resources

and a history of logging, forest benefits were narrowly channeled to local bosses through job allocation, under-the-table revenue distribution and manipulation of the General Assembly which discouraged participation in assemblies (Klooster 2000). Approval of timber contracts was sought more through threats, bribes and violence rather than open discussion using the General Assembly as a forum for communication and oversight. Individuals harvested pine without following management plan guidelines or community permission, most often selecting genetically stronger trees and leaving the deformed or diseased as seed trees (Klooster 1999, Snook 1997). This was in contrast to "successful" communities characterized by well-attended General Assembly meetings.

Finally, we note that the participation of women in formal General Assembly voting is low and one of the main critiques of *Usos y Costumbres* (Carlsen 1999). In fieldwork for this research, survey data shows that women with official status to vote at General Assembly meetings represented a small percentage of the voting body. In some cases, women are pointedly excluded and fined if they attempted to enter General Assembly meetings. No study has shown the impact of gender-based exclusion on Mexico's forest resources, but anecdotal evidence during fieldwork for this study suggested that the allocation of funds from timber operations would likely differ with the inclusion of women in General Assembly voting. A more rigorous analysis of gender and forest management in Mexico is beyond the scope of this study.

2.3 Data

A sample of forest communities in Oaxaca was surveyed from 1997 to 1998. The unit of observation is agrarian communities or subgroups within the communities recognized by community members as the decisionmaking body for timber production. The sample includes two observations characterized by a *colonia* structure, an agrarian legal entity created in the fifties to encourage settlements oriented towards cattle ranching. Civic functioning is similar to the *ejido* and *comunidad* systems. The criteria for including an observation in the study population are that the group owns land for which it has a current management plan and permit that allows commercial harvests, and commercial production occurred in the community during at least one of the three harvest seasons 94/95, 95/96, or 96/97 based on permit files from SEMARNAT. Out of a total population of 95 communities, which produce 80-95% of the commercial timber harvest in Oaxaca

Table 1: Timber Production and Community Characteristics Summary Statistics

Variable	Mean	Standard Error	Number of observations
Kilometers of logging roads	61.65	9.88	43
Years harvested since 1986	8.58	.58	43
Frequency of coffee production	.37	.08	43
Meters above sea level	1549.26	97.05	43
% pop. receiving income from retail shops	5.01	1.00	42
Population	815.18	91.76	38
Forested hectares	5455.33	858.59	43
Forested ha. per capita	.50	.15	38
Hours driving to capitol	5.26	.57	43
Share of non-*comunero* households	.06	.03	42
Village distance to forest			
$<$ 3 kilometers			15
3-12 kilometers			15
$\geq$ 12 kilometers			13
End timber product sold			
Stumpage			16
Roundwood			12
Lumber			8
Finished Products			7

Source: Survey data and *Instituto Nacional de Estadistica, Geografia e Informatica, Conteo 1990*.

(*SEMARNAP* 1999), a random sample of 44 communities or work groups was selected to approximate the proportion of each group in the sample population. The sample included seven of the eight regions of Oaxaca.[1] Pine is by far (82% in the 1996-97 season) the bulk of the total authorized volume. The communities in the sample comprise 22% of the total authorization of pine volume and 27% of authorized volume for other species (oak, *hojosas*, common tropical, cedar and mahogany) in 1997. Forestry production is more concentrated in the mountainous regions of the Sierras. The survey was administered to community authorities responsible for forest administration, conducted with one or more of the community authorities present, and separately with the professional forester responsible for silvicultural management of the community's forest. Questions covered production and contracting details, description of the governance structure and history of timber harvesting in the community, access and use rules for nontimber products and general resource characteristics. Demographic data was obtained from the *Instituto Nacional de Estadistica, Geografia e Informatica*'s *Conteo 1990* and *Conteo 2000*.

[1]Number of observations per region are as follows: Cañada – 1, Costa – 5, Istmus – 3, Mixteca – 4, Sierra Norte – 14, Sierra Sur – 11, Valles Centrales – 6.

A vast literature on deforestation suggests a variety of micro- and macroeconomic indicators to consider in predicting human impacts on forest cover (Cropper, C. and Mani 1999, Koop and Tole 1999, Cattaneo 2001, Tachibana and Otsuka 2001, Hofstad 1997, Hartwick, Van Long and Tian 2001, Bluffstone 1995, Wunder 2001, Geist and Lambin 2002). However, a factor which causes deforestation in one area may have a different effect in another region. Angelsen and Kaimowitz (1999) finds that population growth and national income have ambiguous effects across empirical studies, while road infrastructure, increasing agricultural prices, lower wages and lack of off-farm employment generally increase deforestation rates. Institutional factors have received less attention. But the connection is beginning to be assessed more completely (Bhattarai and Hammig 2001). For example, Panayatou (1997) recommends policies that encourage the enforcement of contracts.

Table 1 statistically summarizes variables suggested by this literature which will be tested in the empirical analysis. The income proxy is the percent of persons receiving income from owner-operated stores in the community. From the community-level survey, we choose this as a proxy as the presence of stores within the community represents an availability of wealth to generate demand for goods. Communities in the sample are located at distances far enough from each other where the presence of a store offers a real convenience if it is viable. A significant source of nontimber forest income, coffee grows in the warmer regions of Oaxaca and correlates positively with lower altitudes. Coffee as it is grown in these regions competes with timber production, as it requires shade best provided by broad-leafed trees with less commercial value.[2] The variable for coffee production takes the value 1, 0 otherwise, if coffee production occurs in the community.

Proximity of the community's population center to the forest resource is measured on a three-point scale, with one for less than three kilometers, two for three to twelve kilometers, and three for more than twelve kilometers.

Heterogeneity in wealth, social status or culture can also affect participation in common property management, although it remains unclear from empirical evidence whether the effect is positive or negative (Varughese and Ostrom 2001, Baland and Platteau 1999, Banerjee et al. 2001, Bardhan and Dayton-

[2]Interviewees in communities with coffee cultivation expressed that they desired, within the limits of the law, to change the species mix from pine to broad-leaf and oak tree species because pine needles were not a good mulch (*abono*) for the coffee plants.

Johnson 2002, Kumar 2002). Land distribution as a measure of wealth disparity in the sample set is not available. Inequality in access to land can evolve over time even in agrarian communities that initially allot full members an equal amount of land for agricultural use. Informal internal land markets, encroachment on the non-parceled commons area or divisions to children in the *comunidades* can lead to imbalances in land access. Although possible, in field observations among the mainly indigenous communities in the sample, large land inequalities did not appear to be a pronounced problem. A final measure of heterogeneity, percent of households in which a resident does not have full membership status[3] (as *ejidatario, comunero* or *colono*) was estimated by the community authorities and will be tested in the regression analysis.

2.4 Intracommunity participation in forestry enterprises

Table 2 illustrates various aspects of collective decisionmaking for commercial forestry. The data are organized by most processed end product sold for comparison of governance with scope of commercial activities at the collective level. The degree to which local elite control has undermined the community's collective choice mechanisms would be captured in our research through variables describing the involvement of the community in the General Assembly, a point we return to below.

Three management processes were explored with community authorities: preparation of yearly harvest volume proposal, choice of buyer and distribution of profits. The General Assembly is rarely a forum to prepare yearly harvest volume proposals. Follow-up questioning revealed that harvest rates are often considered a technical process which the General Assembly as a general body is not sufficiently informed to undertake. The final decision to choose a particular buyer usually lies with community authorities. Harvest proposals and choice of buyer have a slight tendency for specialization away from the General Assembly at higher integration levels, although χ^2 statistics for each possible response (not shown) are insignificant at the 10% level or better, suggesting that the evolution of management proceeds differently across communities regardless of integration levels. The distribution of profits concerns the entire community and is mainly decided at the General Assembly level, consistent with the collective choice literature predicting that decision which have more direct impacts on a broad constituency are decided in more open forums

[3]These persons would mostly be classified as *posesionarios* or *avecindados* under Mexican agrarian law.

(Zusman 1992, Ostrom 1990). This pattern shows little variation across vertical integration levels.[4]

Although smaller committees prepare the management plan, the plan is normally presented to the General Assembly for approval and ratification. We chose ratification of the harvest volume proposal to focus more detailed questions of collective decisionmaking. Community authorities were asked at what point was the last harvest proposal presented to the General Assembly. Communities whose General Assemblies meet to discuss volumes usually meet before the harvest takes place. Three communities stated that the Assembly meets after the harvest, in which case they are only being informed of the volume harvested, although they also said they meet beforehand. Given the context of the interviews, this response indicated a less-than-forthright decisionmaking process in which ratification would logically precede harvesting. Two communities said that the General Assembly meets during the harvest to discuss volumes to be cut.

In many sample communities, attendance in the General Assembly by a resident head of household or registered *comunero* is mandatory, and a person may be subject to fines if he does not attend.[5] Attendance rate indicates a measure of functionality of the governance system. The General Assembly as a decision-making forum is still viable in Mexico, particularly in the *comunidad* structure in relation to *ejidos*. Almost all communities in the sample represent *comunidades*, and representatives from the few *ejidos* and *colonias* in the sample indicated that the Assembly remained a current decisionmaking forum. Therefore, we use attendance rate as a governance characteristic of the willingness of community members to participate in collective forums. A few studies have used attendance rate as a measure of cooperation (de Janvry et al. 2001). Zusman (1988) relates attendance rate to economic performance but notes an imperfect correlation between the two variables. Where general meetings are more frequent, attendance rate may drop in otherwise "well-functioning" communities as the marginal benefit of individual participation at each meeting may decline. In our sample, all except one community reported attendance at General Assembly meetings of one-half or greater of the community's voting population present at the meetings, suggesting a fair degree of participation of the community in forestry matters. The percentage of attendees who speak in meetings drops from attendance rates, which seems reasonable as each individual usually does not speak at the meetings.

[4]One community said that only the CBC decided the distribution of timber revenue while six of the communities reporting that the General Assembly decided also said that the CBC was part of the decisionmaking process. A likely pattern in this case would be that the CBC prepares a proposal which is then discussed in the General Assembly for final decisionmaking.

[5]In come cases, the door is guarded by a person who keeps track of who goes in and out of the meetings.

Most communities need two days of meetings to come to a vote to approve the management plan each year. The lack of correlation with vertical integration for attendance and duration of meetings suggests that the underlying civic functioning is not differentiated by level of investment in timber production processes.

2.5 Forester-Community Interaction

The forester has a number of points of interaction with the community (Table 3). First, the forester can attend General Assembly meetings to make presentations or advise on forestry matters. The form of discussion itself in Assembly meetings varies. As one forester explained, the more vertically integrated communities discuss forestry issues extensively among themselves with little input from the forester although the forester is present to advise as necessary. Communities with timber processing capabilities tend to focus on boundary issues and internal problems in their discussion, while people in integrated communities will discuss forestry management, production, budgets and investments in more detail. In less vertically integrated communities often characterized by less knowledge of forestry issues, the forester participates more to explain programs. So, although the differences in the General Assembly as a discussion forum for the forester are not statistically significant across community production types, the nature of information exchanged may differ.

A second form is smaller advisory councils that may consist of *caracterizados*, or respected members of the community who have completed much of their community service work for the community, older members of the community, or others regarded as having valued knowledge for advising on community issues. In addition, the forester will form smaller teams made up of the CBC and other officers who develop forestry management plans before presenting them to the General Assembly meetings. Overall, the frequency of these small groups is small. Finally, almost all foresters, regardless of vertical integration of the community, hired locally for labor-intensive projects.

These data should be used with caution. Many or all communities have Assembly meetings or send people to assist the forester. But the interest shared by the community in managing the forest varies greatly and affects real exchange of information. In addition, these questions do not gauge the degree of effort the forester makes to involve the community. However, the degree of consistency between responses from the forester and responses of the community authorities in discussion of decisionmaking and involvement seems

Table 2: Community Decisionmaking in Timber Production

	Stump-age (16)	Round-wood (12)	Lumber (8)	Forest Products (7)
Prepares proposed harvest volumes (n=41)*				
Professional Forester	11	10	7	5
Forestry Authorities	4	5	2	2
General Assembly	4	4	1	0
Other	6	1	0	0
Chooses buyer (n=30)				
Professional Forester	0	2	0	0
Forestry Authorities	4	7	5	3
General Assembly	5	3	1	1
Other	3	2	1	1
Decides distribution of profits (n=35)				
Professional Forester	0	0	0	0
Forestry Authorities	2	1	1	2
General Assembly	11	9	5	4
Other	2	1	1	1
When GA convenes to discuss volume (n=36)				
Do not convene	3	4	4	2
Before harvest	7	7	4	3
After harvest	1	1	1	0
During harvest	1	1	0	0
Attendance rate (n=22)				
Less than one-quarter	0	0	0	0
One-quarter to one-half	1	0	0	0
One-half to three-quarters	5	4	2	2
Three-quarters or more	2	3	2	1
$\chi^2_6 = 2.43$ Pr = 0.88				
Discussion participation rate (n=21)				
Less than one-quarter	3	4	1	2
One-quarter to one-half	3	2	1	0
One-half to three-quarters	0	0	2	0
Three-quarters or more	1	1	0	1
$\chi^2_9 = 12.03$ Pr = 0.21				
Average number of meetings days to ratify (n=21)				
	2.4	2.5	1.5	1.7

Columns not adding to totals due to multiple responses or missing observations.

Table 3: Forester-Community Information Exchange (Number of Responses)

	Stumpage (16)	Roundwood (13)	Lumber (8)	F. Products (7)
GA meeting discussions $\chi^2_3 = 2.86$ Pr = 0.41	6	6	5	5
Small group discussions $\chi^2_3 = 4.33$ Pr = 0.23	0	2	1	2
Local hiring $\chi^2_3 = 3.15$ Pr = 0.37	14	10	7	4
Other $\chi^2_3 = 1.69$ Pr = 0.64	5	5	4	4

to be high. For example, forester-community interaction through Assembly meetings, a forester-determined indicator, is positively correlated with attendance rate at Assembly meetings to discuss harvest plans and negatively correlated with communities that said that they met after the harvest had begun to approve harvest plans, both community-determined indicators.

2.6 Rule conformance and forest condition

Performance measures typically rely on one measure such as agricultural productivity or deforestation rate. In doing so, the measures gloss over different dimensions of performance and fail to give a complete picture of the agents' efforts. In complex institutional settings based on common property and communal governance, a single measure may be even less appropriate. Lam (1998) successfully shows the superior model fit of multidimensional versus single measure performance indicators in irrigation systems in Nepal using confirmatory factor analysis. Likewise, we take a multidimensional approach to constructing performance indicators for community forestry in Mexico.

We classify performance into two indicators, rule conformance which refers to the degree to which individual community members follow community-based forest management rules, and a measure of physical condition of the forest which encompasses ecosystemic services and commercial timber production. The two measures differentiate between actions of the community members and the actual physical condition of the forest. This distinction allows for the possibility that current management efforts may not directly correspond to current physical quality of the forest, which may be a function of harvesting practices over

the last decade and before.

Rule conformance refers to rules accepted by the community rather than imposed by outside state officials. All communities in the sample have commercial forestry operations, which in a functioning collective choice system would have been accepted and approved by the General Assembly. State law requires a management plan and permitting for production, a process initiated once the General Assembly has voted for the decision to operate commercially. However, group rules here refer to individual community member actions that would lead to the enhancement or degradation of the forests commercial and noncommercial values.

Consultations with professional foresters, forestry officials and community members informed the survey design and choice of measures for community management practices that signify rule conformance and characteristics of an ecologically sound forest. The performance indicators are constructed from community and forester interviews and review of the forest management plans, with the data crosschecked to the degree possible.[6]

The survey data for assessing forest management effectiveness, or rule conformance, derives from both forester and community interviews. The forester was asked to assess three practices: *Community readiness for preventing and combating fires* refers to how well the community members follow practices to prevent fires, their responsiveness and readiness to fire outbreaks. Responses were recorded on a four-point scale with four for lower levels of organization. Human-induced fires are a leading cause of temperate forest cover loss. Individual farmers frequently prepare agricultural plots according to the *roza-tumba-quema* scheme that uses fire to clear the field. In addition, coal kilns are common. If precautions are not taken in these activities, fires are more likely to escape the individual's control. The timeframe of the survey 1997-1998 included a particularly bad year for fires in Oaxaca, due to climatic conditions. SEMARNAT continues to make efforts to heighten the awareness of communities to preventing fires. This includes educational presentations in regional or community meetings on both individual practices and fire brigades made up of community members to fight fires. *Clandestine harvesting of commercial trees* is a dummy variable that takes a value one, zero otherwise, if the forester indicated that unmanaged extraction of commercial size

[6]The approach of seeking professional opinions reflects methodology used in other common property studies where forest condition and trends in forest condition require a variety of considerations and call for informed judgment (Varughese and Ostrom 2001, Tang 1994, Bardhan 2000).

Table 4: Components of Ecological Indicators

Variable	Mean	Standard Error	Number of Obsvns.
Rule conformance			
Organizational preparedness for fire prevention			
Very high			13
High			15
Low			9
Very low			2
Clandestine timber harvesting commonly occurs?			
No			32 (74%)
Yes			11 (26%)
Forest land clearing occurs?			
No			32 (74%)
Yes			11 (26%)
Extent of clearing			
None			32 (74%)
Low			5 (12%)
Medium/Large			6 (14%)
Rules exist for fuelwood collection			
No			20 (47%)
Yes			23 (53%)
Rules exist for collecting wood for domestic use			
No			10 (23%)
Yes			33 (77%)
Ecological condition			
Percent ha. with "good" or "very good" commercial quality	57.74	4.25	43
Percent ha. 30-60 cm DBH	50.40	3.94	41
Percent ha. with "good" or "very good" soil maintenance	73.84	5.00	38
Percent ha. with "very good" biodiversity	15.58	4.60	43

Source: Survey data

trees was frequent or somewhat frequent. A third measure accounts for *clearing forest land* for agriculture or pasture. Individual community members may request permission from the CBC to clear a parcel of forest to plant crops. In a well-managed forest, the CBC would limit this activity. The measure is a dummy variable equal to one if forest clearing occurred in the last three years before the survey. An additional variable scales the severity of the clearing to equal one if the extent of clearing was considered "small" by the forester, two if "medium" or "large" or zero if no clearing occurred. Two additional variables from community interviews take the value one, zero otherwise, if the community had rules in place for regulating collection of fuelwood and wood for domestic use, usually the two products most heavily collected form forests besides commercial timber. Table 4 gives summary statistics of these components.

Physical condition of the forest refers not only to the commercial potential of a forest, but also its

ability to retain soil to protect water quality and avoid soil erosion, and the degree of biodiversity which characterizes forests of particular soil and climate conditions. Survey interviews with the forester and review of the management plan provide information for a combined measure of *ecological condition* of the forest for marketable and nonmarketable benefits. Foresters were asked to estimate the percentage of hectares according to a five-point scale for commercial quality, soil maintenance and biodiversity. Where possible, these measures were checked against management plan data. Where the management plan did not include the information, crosschecking was done through field observations and informal discussions with informants to the degree possible. Foresters were first asked to estimate the percentage of hectares that could be described as "very good," "good", "medium", "low" and "very low" in *commercial potential* considering existence of commercial-quality species, average DBH, climate and soil conditions. To augment their response, the percentage of forest in merchantable timber as determined by size class was assessed through management plan data. Management plans generally specify the distribution of standing timber by age classes or diameter at breast height (DBH). Foresters indicated that size and age correlated fairly well for the pine forests under their management. We first looked for a distribution for the area of production as a whole. If information for the forest stand was not aggregated, we asked for average ages/DBH for each rotation area or subdivisions (*rodales* and *subrodales*) and averaged to obtain an age/DBH class distribution. Finally, if an inventory was not available in this manner, we asked the forestry engineer for a general estimation using best judgment. For pine, merchantable timber is 30-60 centimeters DBH or 30-60 years of age. Therefore, this data is a measure of current commercial value and applies only to communities with pine stands.

Soil quality assessments considered soil coverage and erosion problems. Some management plans classify forest stands according to degree of erosion which provided a check against the foresters responses. *Biodiversity* was the most difficult to assess during the survey process. Without training in species diversity and ecosystems, foresters can differ in their assessment of biodiversity in the same forest. Therefore, responses should be viewed as first best approximations. Foresters were asked to judge biodiversity by comparing the community forest to the level possible for that type of forest considering climatic conditions, elevation, geography, soil type and number of forested hectares. Since the biodiversity measure is less refined as an estimate, only the percentage of hectares classified as "very good" is reported. Table 4 summarizes these

indicators.

To obtain quantitative measures for forest management effectiveness we use the principal factors technique which seeks linear combinations of variables, called factors, that represent quantities of which the observed variables are expressions (Venables and Ripley 2002). Factor analysis is useful for exploring hard-to-define characteristics that may not be completely captured by one variable. The factor method maximizes the variance among the variables selected and orders them according to how well they explain the data. A principal factorization using the maximum likelihood method and retaining one factor shows that the variables are related in expected ways (Table 5). The first four variables – contraband, readiness for fire control, clearing and severity of clearing – indicate less rule conformance with higher scores, while the last two variables – the presence of rules for gathering fuelwood or wood for domestic use – correspond to more rule conformance with a higher value. The negative signs on these last two variables are, therefore, to be expected, as these variables move in an opposite direction than the first four variables. The clearing variables carry the most weight in this factor model, although all variables contribute to the loadings.[7] Hypothesis tests indicate that the one factor performs better than no factors in explaining the data and that the first factor is sufficient to describe the data (at 10% significance level). Scoring the factor is an additional step that provides weights to each variable to formulate one measure per observation. We score this factor and multiply by (-1) so that increasing values indicate higher performance of rule conformance, or forest management effectiveness (FME).[8]

As all variables expressing forest condition are expressed in percentage of total forested hectares in each community or work group, the forest condition indicator (ECO) averages the number of hectares rated highly in soil maintenance, biodiversity and commercial qualities, in addition to percentage of hectares classified in the 30-60 cm DBH range. Exploratory analysis revealed that the variables are not highly correlated so that a simple average as a single index gives essentially the same information as a factor loading.

[7] We also derived the principal components for the same set of variables, a technique which drops an assumption of normality. The relative weights are comparable to the factor loadings.

[8] See Lam (1998) and Fujita, Hayami and Kikuchi (2000) for other examples using principal components or factors as measures of performance in common pool resources.

Table 5: Factor Loadings: Rule Conformance

Variable	First factor	Uniqueness
Fire control	0.54086	0.70747
Contraband	0.58941	0.65260
Clearing	0.95350	0.09083
Severity cleared	0.97997	0.03970
Fuelwood rules	-0.29657	0.91205
Wood for domestic use rules	-0.24472	0.94011

3 Econometric Estimation

Standard ordinary least squares and instrumental variables methods are applied to estimate two reduced form equations, one for forest management effectiveness and one for forest condition. Estimation is based on the following relationship:

$$y = f(X, Z, \epsilon) \tag{1}$$

where $y = \{FME, ECO\}$ is the dependent variable, X is a vector of organizational design variables that include involvement of the community in General Assembly meetings and attendance rates, Z is the vector of variables for production and community characteristics and ϵ is the error term. In the regression model for FME, years of harvesting is restricted to zero. The expected signs of the independent variables are illustrated in Table 6. Other variables commonly considered in the common pool and deforestation literature are tested, as explained below.

Community involvement takes the value 1, 0 otherwise, if community members discuss forestry management through regular General Assembly meetings. Interaction of this type between the forester and the community represents broad participation and should increase management effectiveness and quality of the forest. Because of the way the data was collected, there is possible simultaneity between Assembly-level involvement and FME and ECO, as these three variables are based on the forester's assessment. For example, a forester may want to present a favorable picture of his work and report both broad involvement in the community and high marks for management effectiveness and quality of the forest. As a check for

Table 6: Expected Signs

	FME	ECO
Organizational characteristics:		
Broad participation	+	+
Attendance rate	+	+
Production characteristics:		
Logging roads	-	-
Years of harvesting	0	-
Community characteristics:		
Income	+	+
Coffee production	-	0

reverse causality, FME explains the involvement variable at the 5% significance level in an ordinary least squares regression with a set of other variables, whereas ECO does not have explanatory power. Therefore, the endogeneity of the forester-community involvement variable in the FME model will be explored in the econometric analysis.

Attendance rate is assumed exogenous and represents a degree of governance "functioning." It is expected to have a positive affect on FME and a positive but weaker effect on ECO. More people attending as a percentage of the community membership indicates a recognition of the General Assembly as a viable decisionmaking forum. The face-to-face interaction and voting process, it is hypothesized, contributes to a flow of cooperative behavior. The ecological condition of the forest, however, is a stock variable and despite good intentions may be tempered by historical use patterns.

Variables added to the regression analysis control for production and general community characteristics. The production characteristics consist of kilometers of logging roads for both indicators, in addition to years of harvesting for the ecological condition indicator. Logging roads may positively or negatively affect quality for management and stock. Roads facilitate access to the forest, encouraging its exploitation (Palo 1999). Yet, easier road access can enhance responsiveness to fires and the application of silvicultural treatments. Years of harvesting could degrade and reduce forests and is expected to have a negative impact on its ecological health.

General community characteristics include income and alternative uses of the forest here represented by

coffee production. The income proxy is expected to have a positive impact on both indicators because of reduced reliance on marginal activities that degrade the forest. For FME, the shade-tree coffee method is expected to have a negative effect if the species mix is changed over time to undermine the pine-oak structure even if counterbalanced by increased responsiveness to fires to protect the coffee plants. In addition, coffee prices during the nineties were decreasing, which could have put more pressure on farmers to diverge from group rules managing the overall forest.[9] However, the effect on ecological condition is ambiguous. ECO measures degradation of the forest in soil retention capability, biodiversity and commercial potential. While shade-tree coffee plots support soil retention and biodiversity (Perfecto et al. 1996, Blackman et al. 2002), their cultivation may erode timber value represented by pine species without loss of tree cover (Blackman et al. 2002).

Other variables associated with deforestation are also tested, such as distance of town center to the forest, vertical integration into the wood products industry, distance to commercial centers, population, population density, percent non-*comunero* residents, dummies for the Sierra Norte, Sierra Sur and mountainous regions and altitude. Vertical integration level is not expected to affect the indicators. The form of contractual arrangement primarily affects investments specific to the commercial production process with an outside buyer and conducted at the community forestry enterprise level (Antinori 2000, Antinori and Rausser 2000), whereas rule conformance and ecological condition of the forest are general performance outcomes subject to the actions of the broad base of community membership influenced by overall community governance characteristics. The vertical integration is exogenous to the models as integration decisions were taken several years prior to 1998, the year in which the ecological indicators apply, and most stumpage communities had been harvesting as such for several years. The effects of these variables will be tested in follow-up regressions rather than in the main model specifications.

3.1 Results

We begin by first analyzing the forester-community interaction alone and then adding the intracommunity indicators in ordinary least squares regressions. For both indicators, forester interaction at the General

[9]Thanks to Allen Blackman for suggesting this point.

Assembly level has a positive and significant impact (Table 7). The production and community control variables have varying explanatory power. Coffee production and logging road infrastructure have the expected negative and significant sign in FME, but an insignificant sign in ECO due most likely to their ambiguous relationship to ecological condition. To check whether the coffee dummy was picking up differences in FME or ECO due to elevation, the measure of altitude above sea level was added to the regression model. This measure produced insignificant explanatory power for rule conformance while the coffee dummy maintained significance, thus favoring the interpretation that the system of individual coffee plots does not necessarily promote group rule conformance in overall forest management. However, altitude is significant and positive at the 10% level for the ecological condition indicator, so that forests at higher elevations tend to score higher in terms of this index.

The income proxy has the expected positive and significant sign for both indicators. The additional explanatory variable, years of harvesting, has a negative and significant impact on ECO, suggesting that forests subjected to a longer history of timber extraction have experienced more degradation. Overall, the model fit is much more satisfactory for FME than for ECO according to the R^2 goodness of fit measure. This set of regressions shows that, expect for the forester-community involvement variables, the variables influencing FME are distinct from those explaining ECO. The ECO model is more limited in its explanatory power but shows that broad communication of information in General Assemblies and higher income promote both rule conformance and quality of forest attributes, while historical logging practices additionally affects current quality of the forest.

Additional variables often associated with forestry management were added to the base model but none contributed significant explanatory power. Vertical integration is not significant for either measure, indicating a range of production possibilities which are consistent with forest conservation and management goals within the community governance framework. Measures of population, population density, proximity of the village population to the forest, distance to the state capitol, distance to another major population center, percent of non-*comunero* households and a mountainous region dummy were tested but did not return significant results.[10]

[10]Further details are available from the authors.

Table 7: OLS Estimation Results for Forestry Indicators

Dependent variable:	Management Effectiveness	Ecological Status
Involvement of community	1.58**	0.20**
	(6.57)	(2.87)
Coffee production	-0.86**	-0.07
	(-3.93)	(-0.97)
Kilometers of logging roads (log)	-0.33**	0.004
	(-3.12)	(0.14)
Years of harvesting		-0.02*
		(-1.83)
Income	0.13**	0.03**
	(3.58)	(2.53)
Constant	0.23	0.45
	(0.57)	(3.67)
Number of observations	38	35
Prob. > F	0.00	0.08
R^2	0.63	0.28

Numbers in parentheses are t-statistics. "**" denotes statistical significance at the 5% level and "*" at the 10% level.

The second set of regressions introduces the attendance rate variable. Again, the model fit for FME is much more satisfactory than for ECO, both regressions exhibit interesting patterns. Attendance rate at Assembly meetings has explanatory power for FME but negative and insignificant impacts on ECO (Table 8). This implies that while a community may be collectively investing in its resource base, the process may be slow to register discernible improvements in the resource stock whose condition is also influenced by other factors, or the sample size is too small to pick up significant variations. The forester-community involvement variable maintains explanatory power in both equations at the 10% level or better. The income proxy loses significance in the ECO regression. Coffee production, again negative and significant in FME but insignificant in ECO, as practiced with the shade-tree method in Oaxaca, does not promote cooperation with group rules to manage the overall forest resource. The result suggests that where people have individual coffee plots, the incentives for group cooperation are likely to decrease, consistent with Ostrom (1990)'s conditions for long-lasting common property management systems (particularly low discount rates, homogeneous effects across stakeholders and burden of adhering to group rules). On the other hand, coffee production does not inevitably lead to forest degradation. [11]

To check for multicollinearity, we use the variance inflation factor (VIF) technique that calculates the multiple correlation coefficient of the explanatory variables in all regressions reported (Chatterjee and Price 1991). All VIFs are less than five and mean VIFs less than 2.50, well within the rule-of-thumb standards, so that evidence of multicollinearity is weak.

The choice of instruments for broad participation entails identifying variables that correlate with the right-hand side variable in question, do not theoretically explain the left-hand-side variable, nor correlate with the error term. We use two variables as instruments in this first approximation of the FME model without attendance rate to maximize the sample size. Communities that said that they met after the harvest to discuss volumes (even if they said they met earlier as well) tend to have no broad participation, as described by the Assembly involvement variable. This measure is negatively correlated with forester-

[11] We explored the weaknesses in the ECO relationships by regressing each component of ECO on the set of independent variables in the base model. We found that the forester-community involvement variable holds its positive explanatory power only for commercial quality, suggesting that forester interactions in General Assembly meetings may be mostly oriented towards supporting industrial forestry goals. Other variables were insignificant. The altitude variable was also checked and is significant and positive for the soil retention and biodiversity ratings, but not the commercial quality and value variables.

Table 8: OLS Estimation Results for Forestry Indicators II

Dependent variable:	Management Effectiveness	Ecological Status
Involvement of community	1.37**	0.19*
	(3.89)	(1.91)
Attendance rate	0.58**	-0.02
	(2.58)	(-0.37)
Coffee production	-1.13**	-0.03
	(-4.16)	(-0.43)
Kilometers of logging roads (log)	-0.23*	0.01
	(-1.91)	(0.32)
Years of harvesting		-0.03**
		(-2.31)
Income	0.14**	0.01
	(2.25)	(0.86)
Constant	-2.02**	0.61**
	(-2.33)	(2.93)
Number of observations	19	17
Prob. > F	0.00	0.39
R^2	0.86	0.42

Numbers in parentheses are t-statistics. "**" denotes statistical significance at the 5% level and "*" at the 10% level.

community involvement via the Assembly and explains it in an ordinary least squares regression at the 10% level. Local hiring, a forester measure, positively and significantly explains broad participation but nevertheless does not explain either of the performance measures. The magnitude of the instrumented involvement variable declines but maintains its significance at the 10% level. We conclude that the ordinary least squares model specifications are fundamentally robust for FME.

4 Conclusion

Rural community governance structure has a long history in Mexico, with social and political significance for its membership. The fairly recent transition into community timber production has introduced a new economic role to which rural institutions are adapting. A question is whether democratic processes produce measurable results in achieving community-accepted forestry management goals. The experimental literature suggests that communication among stakeholders consistently and positively promotes cooperation in common property resource use. To address this question in the field requires a detailed description of common property governance structures and their links to resource management that is currently rare in the empirical research on common property.

Given state-proscribed management systems, we develop variables to measure the degree of broadness of resource management decisionmaking in the community, and test the hypothesis that larger degrees of openness influence resource management performance indicators for rule conformance and ecological condition of the forest, measured as multidimensional constructs of individual actions and ecosystem qualities, respectively. We find that broad-based participation between the forester and the community members in the General Assembly forum is a positive predictor for measures of forest management effectiveness and ecological condition. Participation includes access to both general management and technical information and the opportunity to discuss and approve management plans, even when some decisions are left to more specialized groups within the community governance structure. Further, higher attendance rate at forestry-related meetings has a positive impact on rule conformance. The results coincide with predictions from communication-in-the-commons experiments. However, the rate of attendance at General Assembly meet-

ings to approve the harvest plan, while signifying active community participation in forestry matters, and consequently conformance to management rules, does not translate into greater biodiversity, soil retention and commercial quality of forests as captured in our indicator of forest condition. The network of logging roads discourages rule conformance, as is consistent with the deforestation literature, but surprisingly has no effect on the forest condition index. Rather, years of harvesting is a much stronger explanatory variable. Also consistent with much of the deforestation literature, higher income levels have positive effects due presumably to less reliance on the forest for subsistence needs.

The results suggest that the prospects for introducing a national forest policy agenda into local stakeholder groups depend on the functioning of the collective choice mechanisms in local communities. In this study, the General Assembly is the recognized and preferred forum for discussing issues affecting the community as a whole. The degree of its functioning allows members to benefit from information exchange and possibly reduce conflict over resource use. For devolution to succeed further, the characteristics of access to the decisionmaking process should be evaluated. Finding a balance between the need for more specialized committees and broad inclusion into decisionmaking is one of the challenges of devolutionary policies. Use of democratic processes and forums, where they exist, promotes cooperation with rules and status of the resource but takes an understanding of the local governance mechanisms, forums for discussion and expectations of shareholders regarding inclusion in the process and access to information. The research suggests several avenues for further research. First, forester interaction with only the local elite could constitute bypassing the collective decisionmaking process. The extent that the forester-community involvement variable used here corresponds to imbalances of power could be verified in future research. Second, the research approach used in this paper could be generalized to community management efforts elsewhere in the world where technical expertise combines with community governance systems in resource management, an area of increasing scope in the world's forests. Finally, much work remains to link these results to theories of collective action in natural resource management.

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