Article

Explaining Community-Level Forest Outcomes: Salience, Scarcity and Rules in Eastern Guatemala

Clark C. Gibson, David Dodds and Paul Turner

Abstract: *The residents of the settlement of Morán, located along the border of Guatemala's Sierra de las Minas Biosphere Reserve, have lived in the area for over a century. Despite a lack of community-level rules about protecting their communal forest, limited amounts of arable land, and a high human fertility rate, Morán's forest does not appear over-exploited. This study seeks to explain this outcome given the residents' pattern of forest use and the relative lack of restrictive forest-conservation rules. We first argue that individuals do not create highly restrictive management rules unless two conditions hold: individuals must depend significantly on the resource and they must perceive its scarcity. One of these necessary conditions does not hold in Morán: while community members make use of forest products in their daily lives, they do not consider the forest products on which they depend to be scarce. We also provide evidence about the lack of forest rules by looking at its structure: the pattern of use indicates an optimal foraging strategy. We test these arguments using qualitative and quantitative data from the community and its forests.*

Keywords: community-based conservation, forest, institutions, environment

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INTRODUCTION

THE RESIDENTS of the settlement Morán, living along the border of the Sierra de las Minas Biosphere Reserve in Eastern Guatemala, have farmed in the area for over a century. They also depend on the forest for a number of household necessities, including fuel and construction materials. Given their dependence on these forest products, and the great difficulty they would have in finding substitutes in the market, located hours away along poor roads, why have the residents of Morán failed to construct rules restricting access to forest products?

This study seeks to explain the Morán community's pattern of forest use, relative lack of restrictive, forest-conserving institutions, and the implications of this study for the development of theories regarding common-pool resources[1]. We argue that communities do not create restrictive institutions concerning a resource unless two conditions hold: first, those community members depend significantly on the resource; second, that there is a perceived scarcity of the resource. The second of these two necessary conditions does not apply to the Morán case and as a result, their forest is open to all members to use. We test the implications of the forest's lack of rules by using qualitative and quantitative data, the latter including biological measures of the community's forest. By way of contrast, we argue that the two conditions do hold for agricultural land in the area, and a great number of locally constructed restrictive institutions guide the management and exchange of this valuable resource.

While local residents use the common forest daily, it is in relatively good overall condition, even in the face of significant population increases over the past century. But the growth rate of Morán has been steady, and has benefited from a strong flow of out-migrants, which has decreased population impacts on resources. Consequently, the community's population does not overstrain the significant amount of forest resources in the area. Another important constraint on local behaviour is the Guatemalan government's rule that does not allow additional land to be cleared for agriculture in this sustainable use part of the Biosphere Reserve. While this is imperfectly enforced, local farmers have kept the extent of their fields roughly constant, resulting in a communal forest that is not under immediate threat of being cleared.

Theoretical Issues

When do members of a community construct institutions to manage their natural resources? This is a central question for those exploring common-pool resources, common property, and local-level natural resource management. The answer is, of course, far from straightforward. Scholars have presented dozens of conditions and offered details from hundreds of cases in their efforts to explain the success and failure of collective action regarding natural resources (e.g. Ostrom 1990, 1992a, 1992b; McKean 1992; Wade 1994; Baland & Platteau 1996; Meinzen-Dick et al. 1997; Belsky 1999; Agrawal 2001; Ilahiane 2001).

The conditions forwarded by researchers generally emphasise the costs and benefits that accrue to individuals from group action. These costs and benefits then give individuals incentives to act collectively or not. For example, communities may agree to protect their forests in order to provide a predictable flow of fuel, rather than allow open access—i.e. no rules governing its use—which might destroy the forest entirely. If they create rules to manage their forest, this indicates that their perception of benefits outweighs the costs of creating and maintaining the forest institution. Distance between households, ethnic tension, unequal distribution of the costs and benefits of the proposed institutions, lack of enforcement of the rules due to the costs of monitoring, etc., are all examples of conditions that might drive up the costs of cooperating to such a level as to preclude collective action (e.g. Ostrom et al. 1994; Belsky 1999; Gibson et al. 2005).

Ostrom, building on her own work regarding the management of common-pool resources, elaborates a model that incorporates many of the most well-known costs and benefits of collective action regarding one natural resource, forests. In this model, Ostrom constructs lists of the attributes of the natural resource and of the appropriators of that resource that might affect the likelihood of whether or not an individual will choose to invest time in a collective solution (Baland & Platteau 1996: 286–289; Ostrom 1998; see also Ostrom 1992b: 298–299). The implication of these two sets of attributes is that each factor influences the calculus of individual users, and therefore affects the probability that collective action will emerge around forest resources (see Table 1).

These lists do not, however, state which attributes—or which level or combination of attributes—are necessary conditions for the emergence of collective action (Gibson 2001). This is, of course, in great part a matter for empirical study: such attributes will be present to varying degrees and interact in different ways over space and time. If enough cases employ concepts similar to Ostrom's useful list and agree to comparable units of measurement, comparisons can be made to determine which attributes at what levels are more important than others to promote collective action (see Ostrom & Wertime 1994).

But we believe that, in fact, research can go further in examining the necessary conditions for the collective management of natural resources. We suggest that two of Ostrom's attributes are more than just additional influences on individuals' cost-benefit calculations; indeed, we assert that these two conditions are necessary to motivate individuals to construct collective institutions regarding natural resources: (1) individuals must depend on some forest resource which is salient to their livelihood; and (2) they must perceive the resource to be scarce (see Ostrom's attributes **AI** and **R1**). We discuss each of these conditions in turn.

Table 1

Attributes of resources and individuals influencing collective participation (from Ostrom 1998)

Attributes of the resource:

R1.	Feasible improvement: The forest is not at a point of deterioration such that it is useless to organise or so underutilised that little advantage results from organising.
R2.	Indicators: The quality and quantity of rapidly growing forest products provide reliable and valid information about the general condition of the forest.
R3.	Predictability: The availability of forest products' units is relatively predictable.
R4.	Spatial extent: The forest is sufficiently small, given the transportation and communication technology in use with which users can develop accurate knowledge of external boundaries and internal microenvironments.

Attributes of the users:

A1.	Salience: Users are dependant on the forest for a major portion of their livelihood or other variables of importance to them.
A2.	Common understanding: Users have a shared image of the forest (attributes R1, 2, 3 and 4 above) and how their actions affect each other and the forest.
A3.	Discount rate: Users have a sufficiently low discount rate in relation to future benefits to be achieved from the forest.
A4.	Distribution of interests: Users with higher economic and political assets are similarly affected by a current pattern of use.
A5.	Trust: Users trust one another to keep promises and relate with reciprocity.
A6.	Autonomy: Users determine rules without external authorities countermanding them.
A7.	Prior organisational experience: Users have learned at least minimal skills of organisation.

Individuals must depend on a resource (i.e. it must have the attribute of salience to their livelihoods) in order to create institutions to manage its use. The reasoning for this condition is straightforward. Unless a resource is important, individuals will not incur the costs entailed in constructing an institution to manage it. Such costs can be quite high since they must include decision making, monitoring and enforcement structures at a minimum (Ascher 1995). The salience condition is unrelated to the abundance of a resource. For example, oxygen is salient whether or not it is abundant or scarce.

While somewhat obvious, this condition may cause conservationists great frustration as they seek to build projects with the help of local communities. There is abundant evidence that communities can effectively govern their forests (and other natural resources); in many cases a relationship with an outside organisation has helped to produce good management. But conservationists and the members of the communities with whom they work can possess different sets of preferences over natural resources (Bailey 1996; Agrawal & Gibson 2001). Outsiders may value the biodiversity, global climate stability or watershed benefits offered by an intact forest the most. Community members, on the other hand, will invest their resources to garner benefits for their household or community needs first, which may or may not have any relationship to global or regional public goods. Where benefits to a community are not forthcoming, or are given with little participation or ownership at the local level, conservation projects sponsored from the outside will remain fragile (e.g. Ostrom 1990; Lam 1998; Hulme & Murphree 2001).

The second condition is also relatively well known to both academics and conservationists: people must perceive a resource to be scarce in order to want to contribute to a collective solution. If individuals view a resource as plentiful, they will not be willing to endure costs to manage it. Indeed, anthropologists following Boserup's (1965) thesis of population-induced agricultural intensification, argue that without scarcity there are few reasons for people to create and maintain rules about resources (e.g. Harner 1975: 125; Johnson & Earle 1987: 10–11; Netting 1993: 157–188). Perception is key here. For example, additional lands to which to migrate may not actually exist, but if people perceive that they can use up a forest's resources and move on, they will be less inclined to organise to manage their current actions and resources (Gibson & Becker 2000).

We suggest that both of these conditions must be present before members of a community will construct institutions that restrict their access to their own natural resources. If individuals do not depend on a resource, they will not organise to manage it whether or not it is scarce. No one is going to spend time and energy to protect and allocate something that they do not need. If individuals do not perceive a resource as scarce, they will not organise to manage it whether or not it is valuable to them. Water may be required for human life, but a community living with an abundance of fresh water and easy access to it is not likely to spend the time and energy to manage it.

There is one context in which our argument may not hold: sacred forest. The relationships between scarcity, dependence, and aspects of spirituality are far less clear than the ones of instrumental rationality that we have explained here. For this study, we exclude such cases.

To examine the importance of salience and perceived scarcity as necessary conditions for the creation of rules governing a resource, we explore the case of Morán, a community located in the Sierra de las Minas Biosphere Reserve in eastern Guatemala.

RESEARCH METHODS

We collected data in the communities of Morán (sixty households) and Naranjo (nine households); altogether they have 290 individuals. Since kinship and forest use closely link the communities together, we treat them as one community for this study and hereafter we use the name Morán to refer to both. We also collected forest data in two areas of the surrounding watershed, which we refer to as El Sitio and Palmar.

In this site, we used a set of eleven data-collecting instruments designed by the International Forestry Resources and Institutions Research Program (IFRI) to collect site-specific social and ecological data (for the details of this approach, see Ostrom & Wertime 1994 and www.indiana.edu/~ifri/). The eleven instruments together capture the kind of information about a given site that would result from a highly detailed case study, but they do so systematically by classifying the collected information in terms of approximately 900 variables (including some long text variables to capture context-specific and historical information). Prime variables of interest include: socio-economic and political structures at a variety of levels; detailed institutional rules; historical, demographic, settlement and market-related changes; features of local user groups and their organisation; relationships between forests, users and the products forests provide; climate and ecology; flora and fauna; and measurements of forests in representative plot samples. Designed between 1992 and 1994 on the basis of extensive feedback from nearly 200 academics and policy analysts, these instruments have been periodically updated with the help of collaborating institutions from around the world. IFRI scholars have gathered data from 183 sites and 320 forests (IFRI 2004).

To gather data, IFRI research of social and natural scientists typically live in a research site for 4–6 weeks. In the present case, thirteen research team members (seven social scientists and six foresters as well as fifteen forestry students) lived in the Morán community from July to September 1996 (31/07/96 to 26/09/96). IFRI research teams always include at least one social scientist from the site's country in order to begin the study with a substantial understanding of the fundamental issues of the area. The team attempted to discuss uses, practices and attitudes towards the forest with an adult from every household in the settlement (N=69). We visited with fifty one individuals (twenty eight females and twenty three males). Households missing from our study included ten reported by other community members as travelling or having out-migrated. We did not locate an adult representative for the remaining eight households. It is possible that our lack of data for the missing households (26 per centof total households) biases our general impressions of community-forest dynamics. Given the consistency of the information we gathered from the remaining three-quarters of Morán, and the information gleaned from interviews with individuals from the government and non-government organisations (NGOs), we think our general conclusions have firm support[2].

Team members used open-ended discussions, guided by the topics as listed on the IFRI forms. The length of discussions in Morán ranged from 1–3 hours; we had repeat visits with seventeen individuals to clarify or augment their first responses. Team members recorded notes for each discussion on paper. We visited each household and went to about half of the households' agricultural plots after consulting with the adults as to when the most convenient times for such a discussion could take place. As a result, about two-thirds of the discussions occurred in the evening.

Team members met every evening while in the field to compare notes about residents' responses. IFRI data are at the community level—not household or individual. For example, variables that come from the *user group form* relate to the membership and structure of the formal or informal groups that use the forest, but they do not record data from each member; data in the *user group to forest form* explore the patterns of each group's use of a forest, but does not track each individual's use of the forest. The research team's evening meetings therefore use notes and experiences to reach consensus on the community-level measures written on the IFRI forms.

IFRI researchers also interview officials from relevant government organisations and NGOs, and gather census and cadastral data. For forest data, team members collect data from randomly selected, 10 m radius, circular plots at each study site. Within each plot, mature trees (at least 10 cm in diameter at breast height (dbh)) were examined to determine species, diameter and height. Sapling data are collected from 3 m diameter concentric circles and ground cover information from 1m circles. The sampling strategy for forestry data involves choosing sites that community members report that they use and those they do not. Forest areas are chosen to prevent bias based on elevation, insolation and slope. IFRI teams always include country experts in the social and ecological systems of the research area.

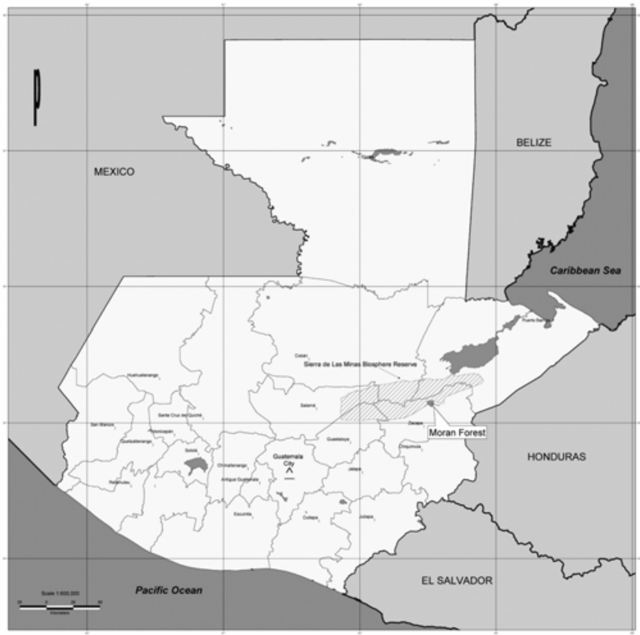
STUDY AREA

We used the research methods described above to examine the importance of the scarcity and salience conditions in Morán. The Reserve was created in 1990 by an act of the Guatemalan Congress. The Reserve covers approximately 2363 km^2, the entire extent of the Sierra de las Minas, a transverse range running east-west along the north bank of the Río Motagua (see Figure 1). Morán sits on the south slope of the Sierra de las Minas, in the Río Santiago, a sub-watershed of the Río Motagua (see Figure 2). The Río Santiago watershed maintains a southward aspect and ranges in altitude from 150 m to over 1500 m in elevation, with Morán located at 1216 m.

The Sierra de las Minas range is approximately 130 km long and at its highest point reaches 3200 m above sea level. The slopes of the Sierra de las Minas mountains rise from the Motagua Valley that creates the Motagua-Polochic system that boasts 80 per cent of species found within Guatemala and Belize (Nature Conservancy 2007). Broad leaf tropical forests cover the north slope of the Sierra de las Minas range, due largely to high levels of precipitation (2000+ mm) caused by the interaction of Caribbean trade winds and mountainous topography. The south slope of the Sierra de las Minas is drier: the lowest elevations in the Río Motagua valley are host to thorn forests. Increasing elevations on the southern slope give way to oak (especially *Quercus tristis*).

Figure 1

Location of Morán in Guatemala

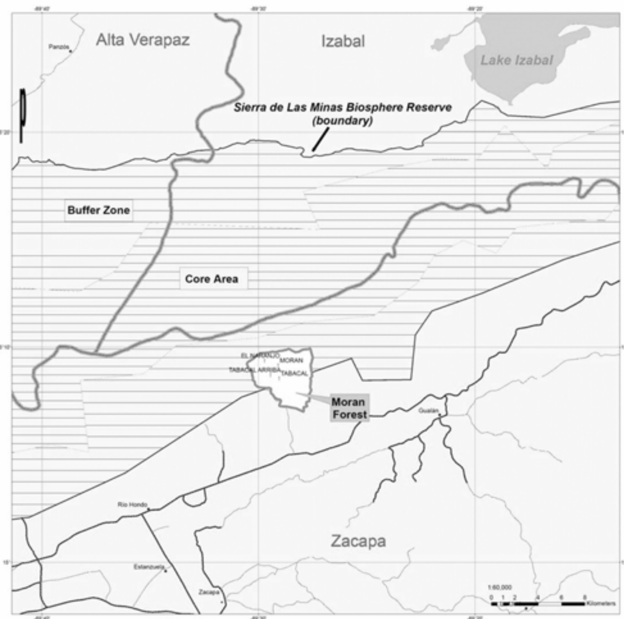


Morán provides an interesting case study in human-forest interactions. This population has lived for over 100 years with its local forests—forests which still exist although modified by human use. Population growth appears to have been slow and steady over the last hundred years; the oldest residents remembered about five houses being present in early Morán; now there are sixty. In the last 20 years however, out-migration seems to have become an important population valve in the context of poor and scarce agricultural lands: many adult children of the older couples have moved to the Caribbean coast of Guatemala, the Petén frontier region, or to Providence, Rhode Island.

Residents of Morán are ethnically *ladino*, that is, people of mixed Spanish and indigenous ancestry. They speak Spanish and identify themselves as Guatemalans, observing national holidays such as Independence Day (September 15). Historically, their religious orientation has been Roman Catholicism, though now a majority of residents consider themselves Protestants: Morán maintains a full-time Evangelical pastor; Naranjo has a small Catholic chapel which is infrequently visited by an itinerant priest. The people of Morán say that a man named Morán settled on the Río Santiago approximately 100 years

Figure 2

Morán study area



ago though he eventually left the area (according to local legend) because his wife was attacked and killed by a jaguar. The majority of residents trace their ancestry to migrants from villages in the neighbouring watershed immediately to the west of the Río Santiago watershed.

The people of Morán are *campesinos*, farmers practicing *milpa* agriculture traditional to most of Central America. The most important crops are maize and black beans. Other tropical crops (e.g. coffee, plantains, manioc and yams) and fruit trees (e.g. oranges and mangoes) are grown, but are secondary in importance to maize and beans. Agriculture is almost entirely for subsistence and direct consumption by households; although small amounts of excess harvests are sold in the regional market. Cattle are also important as a form of wealth and financial security. Fields and pastures occupy mostly steep slopes within the Río Santiago watershed as there is little flat land in the area (forest plots sampled ranged from 17° to 45° in slope gradient). Soils are generally shallow and rocky and poor for agriculture; *milpa* farmers in Morán now use commercial chemical fertilisers, herbicides and pesticides to increase their yields.

The history of land tenure which shapes the use of agricultural land and local forests is complex, involving several layers of legal demarcations, usufruct rules and reserve management policies. According to the national cadastral survey of Guatemala, the majority of the area now utilised by Morán for agriculture, cattle pasture and extraction of forest resources is municipal land locally called 'El Sitio' or The Site. (There are also large private areas of the map designated by owners' names.) Within El Sitio are located communal agricultural lands (*trabajaderos*) worked and fenced together by community members. Also smaller usufruct plots, known as *tierras con dueños* are found in El Sitio. Rights to work in these plots, though not legal, are recognised by the community members and can be inherited, sold and rented. Apart from the municipal lands, mostly in the northern extent of the Río Santiago watershed, are found *tierras privadas*, lands legally demarcated as privately owned by the national cadastral survey. However, just as in the municipal lands, individual or family usufruct plots '*con dueño*' are scattered across the land demarcated as private. As delimited by the Master Plan of the Sierra de las Minas Biosphere Reserve, Morán and the majority of lands economically important to its residents, falls within the buffer zone of the Reserve; within this zone the law allows the sustainable use of resources to better the quality of life of its inhabitants.

El Sitio's municipal lands host two kinds of biological forests: oak and pine. These forests are used for three main purposes: (1) extraction of *ocote*, or resinous pine, for kindling; (2) extraction of firewood, oak varieties being preferred because they create less smoke (though pine is sometimes used) and (3) pasture areas for cattle which browse freely through the understory.

Each of the three economic activities has its own technologies and practices. *Ocote* is most often cut by men using an axe. Individuals may fell an entire pine, cut it into short lengths, and then split the pieces; a burro or mule is used to carry the split wood home in a bundle called a *carga*, the amount a mule can carry on its back. Sometimes men cut *ocote* from live standing trees simply by slashing through the bark of the pine trunk and prying the quantity of desired kindling from the resinous interior wood. Men and women collect firewood; the preferred pattern is for men to cut firewood with an axe and carry it home with the aid of a beast of burden. However, if men are away or unable to cut firewood, women and children will go out to collect it, most often cutting wood with a machete and carrying it home in a bundle on their heads. Almost all households collect *ocote* and firewood. Less than half of the households, however, own cattle. The aggregate herd is about 225 head. All cattle, at various times during the year, range throughout the forested lands of El Sitio, though other pastures (e.g. privately owned pastures or usufruct pastures) are also important for maintenance of cattle. *Campesinos* typically burn the ground cover of these common access forests at least once a year to foster new growth of pasture grasses in the forest.

Four significant factors shape the pattern of forest use by members of the Morán community: the difficulty of travelling to nearby markets, the laws governing forest use in Guatemala, individuals' perception of the quantity of forest products, and how forest products fit into the pattern of local agricultural production. Together, these factors have led to a situation in which use is not greatly constrained in the forested parts of El Sitio land: rules-in-use for the forest are few.

While members of the Morán community live relatively close to local markets (10–20 km), the steep slopes and the poor road found in this part of the Sierra de las Minas make the trip to markets very difficult. No one in the community owns a motor vehicle and so travelling to markets must be done by foot or on horseback. The majority of community members walk, a round-trip for a young man can take anywhere from 4–5 hours, and up to 8 hours for those less fit.

Such difficulties reduce the economic returns to the marketing of forest products by local community members: neither firewood nor timber has been sold by community members to outside markets and only one member of the community regularly sold *ocote*. The difficult access has also prevented many outsiders from taking a great deal of Morán forest products as well. With the exception of a municipality-sanctioned timber company that cut thousands of trees 20 years ago, community members believe that outsiders have little effect on the condition of their forest. The costs of transport have reduced the effect of external market demand for forest products from this watershed. The reverse is also true: it would be very expensive for members of Morán to purchase and transport fuel wood and wood-based building materials from the town to the community.

The multiple laws and policies that govern the forest are ambiguous, overlapping and difficult to enforce in the Río Santiago watershed. Nevertheless, these laws have affected the pattern of forest use in Morán. The most significant laws and policies are found in the Laws of Protected Areas (Decree 4-89), the Forest Law (Articles 98 and 99), and the Master Plan for the Sierra de las Minas Biosphere Reserve. In general, these laws and policies allow for the subsistence use of forests, but set certain limits on the amounts of products taken.

Community members do not always know exactly what these limits are. In Morán, a community member has been hired as an extension agent for Defensores de la Naturaleza (DN), a NGO that has been given executive authority by the government to manage the Biosphere Reserve, in which the community is found. The extension agent has discussed one particular policy with his fellow community members, i.e. that land cannot be cleared for agriculture. This policy is based on DN's policy of preventing any change in land-use, so as to stabilise forest exploitation. Local individuals know about this general policy. In addition, because government personnel have investigated forest exploitation in the community in the past, individuals fear government intervention.

Thus, in practice, community members rarely violate the government laws, so that their *de facto* activities generally reflect the *de jure* rules and they rarely clear additional forested lands for new agricultural plots.

Subsistence use dominates the manner in which the forested lands of El Sitio fit into the local people's livelihoods. The forest products taken from El Sitio (pine and oak) predominantly relate to fuel use. Community members also use common forests for cattle grazing. Thus, common economic activities impacting the forest may broadly be described as foraging, whether by humans (kindling and firewood collection) or by cattle (grazing).

TESTING THE IMPORTANCE OF NATURAL AND SOCIAL FACTORS

In this section, we provide some evidence that links Morán residents' perception about forest condition with the few rules they have created to govern its use. We first report the more qualitative data, and then move on to test our contention with more direct measures of the forest.

The members of Morán did not tell our research team of any constraints on their use of the common forest. That is, we found no rules, formal or informal, that members had created to limit their access to El Sitio. While individuals in nearly all households (sixty) mentioned that outsiders were not allowed to harvest products, they did not indicate knowledge of such rules restricting community members.

Members also generally perceive firewood, *ocote* and pasture land to be abundant in the El Sitio forest. In our interviews, some of the households (eight) acknowledged that it takes more time to walk to gather firewood than in past years, they see this as an inconvenience but not a crisis. The vast majority of households are not worried about their sources of wood for fuel or building materials. Also, while some members understand that the amount of pasture land is limited, they also perceive that it is satisfactory for the amount of cattle owned by individuals.

This general perception of abundance combined with a lack of community rules regarding the use of the common forest provides some evidence for the link between a perception of scarcity and the lack of forest institutions. This inference is strengthened when compared to the community rules governing the use of agricultural land.

The research team found numerous community-constructed rules governing agricultural land and agricultural practices. Unlike the forest, agricultural land meets both conditions forwarded as necessary for the construction of institutions: salience and perceived scarcity. Community members strongly conveyed to the research team that they consider the good agricultural land—clearly highly salient to a rural-based economy—to be in short supply. This is especially true given DN's policy that the use of land-use may not change, which has the effect of stabilising the total amount of arable land in the community. Remember that the formal rights to agricultural land in this watershed generally does not lie with the residents. And yet informal rules governing rights and responsibilities have been developed and enforced by community members. We discovered—among other things—that community members hold yearly meetings to decide on the allocation of arable land within El Sitio, negotiate among themselves to establish rental and sharecropping contracts, and share an understanding about the rules regarding the burning of arable lands. The ubiquitous barbed-wire fences around land also indicate that community members take individual as well as collective action to protect those things they consider valuable and scarce. As the literature regarding common-pool resources has abundantly found, local communities can self-govern their natural resources under the right conditions (e.g. Berkes 1989; Ostrom 1990; Baland & Platteau 1996; Hanna et al. 1996; Agrawal 2001). The contrast between institutions building regarding the forest and arable land, then, provides another type of evidence that not does the community create informal rules, but that they do so over resources that they find both salient and scarce.

To augment our argument, we attempt to test the lack of local-level rules by examining parts of the structure of the forest itself. We argue that outcomes on the landscape may indicate the existence or lack of local-level rules about forest use. For example, if a community had a prohibition on cutting of large oak trees, we would expect to find more oaks in their forest than if there was no such a rule. If a community allowed cattle to graze in the forest, we would expect to find less groundcover than in a forest in which a community had prohibited grazing.

If a community did not have rules about using forest products, as indicated from the interviews with residents, we would expect a different pattern of forest vegetation than one with rules. In the former case, we hypothesise that the pattern of use might follow optimal foraging theory (Hayden 1981; Stephens & Krebs 1986), particularly spatial models of patch use (MacArthur & Pianka 1966; Winterhalder 1981). Without local institutions to constrain subsistence behaviour, individuals use the forest in ways to maximise returns to individual effort[3].

Such a view fits generally the theories emerging from the common property literature that people construct institutions under the condition that the expected value of creating an institution to manage the resource is positive (Ostrom 1990; Bromley 1992). In this case, because locals are not concerned about the supply of the products offered by the forest at this time, there is little attempt to construct management institutions. (This may change, for example, if community members decide that a forest product is being overused. In such a case, they may create a formal or informal rule to reduce its harvesting.)

Using simple biological measures, we find some evidence of optimal foraging patterns by Morán's residents by examining the forests of El Sitio. In El Sitio, the team took measurements from forty three plots in El Sitio forest (frequencies of these measures for El Sitio are found in Figure 3), which is located close to the community.

There is clear evidence that humans use El Sitio to a large extent. Evidence of cutting and fire was found in nearly half the plots sampled (fire could also be a natural phenomenon, but it is used to clear fields and fires are often set to the surrounding forested area). The most significant disturbance discovered was that caused by livestock: every plot sampled in El Sitio showed the presence of cattle (droppings or hoof prints). Finally, El Sitio forest plots reveal that cutting far outnumbers the natural disturbances of insects and erosion[4]. In contrast, no cutting was evident in the Palmar forest and only one plot had evidence of livestock based on the three plots surveyed.

To test better the hypothesis that Morán's residents have not created rules about the forest which they depend on but do not find scarce, we construct two simple regression models explaining different measures of forest condition. Again, without rules to constrain behaviour, we argue that the El Sitio forest would be used in a pattern consistent with a simple optimal foraging framework, maximising economic returns while minimising labour costs across space. This in no way indicates that community members could not create rules. Instead, we test whether there is evidence of rules on the landscape, which, from our qualitative evidence, we would hypothesise are lacking. Both models attempt to separate the natural and human factors that may affect the forest. We select pine as an indicator species since locals use it for fuel wood (especially *ocote*) and construction.

Figure 3

Types of distributions found in El Sitio forest sampled plots

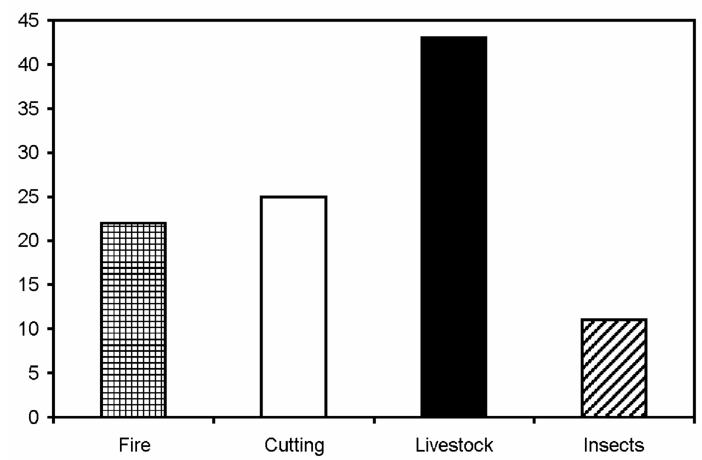


Table 2

Summary of variables for regression models 1 and 2

Variable (measures per plot)	Units	Min	Max	Mean	Std. dev.
Pine trees per hectare	Stems/ha	31.82	732.11	286.48	190.99
Avg. dbh of pine	Centimetres	15.43	50.13	30	11
Elevation	Metres	715	1400	1106	186
Steepness	Degrees	17	42	28	8
Insects	Scale 1-2	1	2	1	.47
Distance to settlement	Metres	0	115	73	20
Distance to road	Metres	3	76	33	22

N = 33

The first model uses the average diameter at breast height of pine trees per hectare as a dependent variable. We hypothesise that since pine is an important species in this ecosystem as well as a major product used by locals—for firewood, *ocote*, and timber—the impact of human use of pine would be captured by the size of trees remaining in each plot.

***Model 1.* Pine dbh=Stand density+Elevation+Steepness+Insects+Distance to Settlement+Distance to Road**

The first four independent variables attempt to control for the most important natural factors affecting the size (in dbh) of pine trees (see Table 2). The independent variable **Stand density** is the number of pine stems per hectare; increases in the number of pine trees in a given space produce smaller trees due to crowding effects when a forest is not heavily extracted, as is the case in this area. The independent variable **Elevation** is the elevation of the forest plot, measured as metres above sea level. Elevation could inhibit the access or portability of timber. **Steepness** is the steepness of the forest plot, measured as the plot's slope in degrees. In many cases the size of trees will decrease as slope increases since trees have more difficulty establishing and maintaining themselves. This variable might also capture human intervention, since it is difficult to access trees on steeper slopes. Higher levels of **Insect** damage may also affect the dbh of pine.

The last two independent variables attempt to capture social effects on the size of pine trees in the El Sitio forest. **Distance to settlement** is the independent variable representing the distance, measured in metres, between forest plots and the closest house located in the Morán community. This independent variable seeks to capture the effect of distance on the size of pine trees. If community members are trying to maximise their return to effort, then plots closer to settlements should contain smaller pine stems than plots located farther away. **Distance to road** on the other hand captures the distance, also measured in metres, from road to forest plot. The one road linking the Morán community to the outside world both traverses and follows the edge of El Sitio forest. Because it would be easier for an individual to transport pine products by road, we hypothesise that the larger pine trees would be taken from plots closer to the road. Thus, as distance from the road increases, we expect to an increase in pine size per forest plot.

RESULTS

The results of the model provide support for the hypothesis that the residents of Morán use the El Sitio forest in a way unconstrained by local rules (see Table 3). The overall fit of the model is relatively strong, with an adjusted R^2 of 0.75 and a robust *F*-statistic of 13.2, indicating that the variables employed explain much of the variance of the pine diameters in the sampled plots.

The independent variables yield interesting and important results as well. First, stand density and elevation are 'natural' variables that are strongly associated with pine dbh. The coefficients of stand density and elevation are in the right direction: increases of both decreases the dbh of pine trees in this forest. And each is highly significant, with *p*-values of less than 0.001. The other 'natural' variables, insect damage and steepness, did not achieve significance in this model.

The only 'social' variable that is significant ($p<0.093$) in the pine dbh model is distance to road. This variable is also in the hypothesised direction: as the distance from the plot to the road increases, so too does the average size of pine trees. By using the β coefficient from this variable we find that for every metre a plot is away from the road, we can expect its pine trees to have another 0.182 cm in diameter; a 10 m distance from the road increases the dbh by 1.82 cm.

The insignificance of the distance to settlement variable is not surprising. Given the extreme slopes that surround the community, any direct line to a

Table 3

Determinants of pine dbh

Independent variables	Coefficient	Std. error	*t*	*P*<|*t*|
Stems/ha	–0.038	0.009	–4.22	0.000
Elevation	–0.038	0.099	–3.83	–0.001
Steepness	–4.729	7.193	–0.66	–0.517
Insect damage	10.329	3.158	3.27	0.003
Distance to settlement	0.026	0.037	0.70	0.493
Distance to road	0.182	0.104	1.75	0.093
Constant	47.816	12.439	3.84	0.001

$N = 33$
$R^2 = 0.753$
Adjusted $R^2 = 0.696$
F-statistic = 13.22
Prob>*F* = 0.000

plot is difficult to travel without walking up and down ravines and through agricultural fields. Thus, it makes sense that a forager would use the road, rather than the distance as the crow flies, to reach the areas of the forest from which they choose to harvest.

In our second model, we use another biological indicator—stand density—as the dependent variable. The independent variables are the same (except for stand density) as in the first model, as is the hypothesis, i.e. without rules, we should see an optimal foraging pattern of forest use.

***Model 2.* Pine Stand Density=Elevation+Steepness+Insects+Distance to Settlement+Distance to Road**

The results of the model can be found in Table 4 below. The fit of this model is also strong, with an *F*-statistic of 7.62, and Prob>*F*=0.0001. The results show that none of the 'natural' independent variables in this model captures the variation of number of pines per hectare. In fact, the only variable that turns out to be significant in this model is distance to road. Using the β coefficient to calculate the effect of distance to road on the density of pines, the model predicts an increase of about six more pine trees per hectare for every metre a plot is located away from the main road. Using the maximum distance from road in our sample, 76 m, we would expect about 461 more pine trees per hectare.

The only independent variable that is significant in both models is a plot's distance to a road. This result provides support for the argument that members of Morán are using their communal forest that minimises their efforts to obtain goods, unconstrained by rules that might affect their harvesting of pine. As indicated by number and size, pine trees in the measured plots are negatively related to the nearness of the plot to the community's road.

Table 4

Determinants of pine stems per hectare

Independent variables	Coefficient	Std. error	*t*	*P*<|*t*|
Elevation	0.027	0.22	0.12	0.904
Steepness	6.305	159.53	0.04	0.969
Insect damage	80.013	68.33	1.17	0.252
Distance to settlement	0.213	0.826	0.26	0.798
Distance to road	6.068	1.99	3.04	0.005
Constant	–197.057	273.27	–0.72	–0.477

$N = 33$
$R^2 = 0.585$
Adjusted $R^2 = 0.509$
F-statistic = 7.62
Prob>*F* = 0.0001

These quantitative analyses using biological data are consistent with our qualitative evidence. Of course, these data cannot account for a lack or existence of rules *per se*—the differences in dbh or number of trees are not of enormous magnitudes. But they do show that the use of forest products is more likely driven by the idea of optimal foraging, and this pattern is more likely in settings where rules are not operating.

CONCLUSION

Given the incentives generated by their social and biophysical environment, it is not surprising that community members from Morán have not created institutions to manage their forest resources. Community members perceive their most valued forest products as relatively abundant, easily accessible and under little threat from either insiders or outsiders. The community members' behaviour matches what many observers would predict: without the need to create rules to govern the use of their forest, they do not make efforts to do so. Residents did not inform researchers about any local rules that would constrain harvesting. The lack of forest rules contrasted strongly the detailed *de facto* institutions that govern agricultural land, which is held to be very scarce in Morán. Use of land is negotiated between community members even though they hold no formal title. Quantitative evidence demonstrated that the pattern of use in the area conformed to an optimal foraging pattern: in the absence of institutional influences on harvesting behaviour, resources are sought in an economically efficient manner across space.

This does not mean that the forests in the area are not under a more long-term threat, or that there is not an interaction effect going on between forest and agriculture. As in many parts of the world, population growth can threaten the forest in the long run—after all, the community does depend on forest products and the watershed is limited in size. One way the community has been spared this pressure is through out-migration. According to the residents, population growth appears to have been slow and steady over the last hundred years; the oldest residents remembered about five houses being present in early Morán; now there are sixty. In the last 20 years however, out-migration seems to have become an important population valve in the context of poor and scarce agricultural lands: many adult children of the older couples have moved to the Caribbean coast of Guatemala, the Petén frontier region, or to Providence, Rhode Island. Without such migration, there may have been significantly more pressure to use both forest products and to convert more forest lands into agricultural fields. This again points to the necessity of the scarcity condition.

Another important feature of this case revolves around the enforcement of the land-use pattern by Defensores (Fundación Defensores de la Naturaleza). The community does not have or enforce rules about forest use, but Defensores does. Community members' desire for more land is clearly not at the level where it challenges the enforcement level of Defensores; the little patrolling that the organisation does apparently staves off any significant conversion. But this may not be the case if demand increased greatly, either through population growth or another means.

There are several threats to the validity of this study's findings. First, while it is possible that locals could have misled the research team, the opinions of one anthropologist with experience in rural Honduras and two Guatemalan rural sociologists suggest that they did not. Second, the quantitative evidence could be weak because only pine species were included in the tests. It could be that rules about other products do indeed exist that we failed to test. The view of the social scientists on the team does not support this assertion either. Pine and oak were the only species mentioned significantly be community members and oak was not in enough plots to be able to test well.

In sum, this case helps provide evidence for the argument that two conditions are necessary for individuals to create institutions: importance to livelihood (salience) and perceived scarcity. Certainly, these are not sufficient conditions: the many additional conditions forwarded by researchers to account for successful collective action are surely important at different levels and combinations across different settings. But this study has attempted to take two of the many conditions forwarded and elevate their theoretical if not practical importance. We hope this work stimulates others to test these conditions using other cases and data so as to refine our understanding about local rule making for natural resources.

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Notes

1. We follow North by defining institutions as 'the rules of the game in society or, more formally, as the humanly devised constraints that shape human interaction" (North 1990: 3).
2. We met with representatives of Fundacion Defensores de la Naturaleza, Facultad de Agronomia-Universidad de San Carlos, Food and Agriculture Organization—Forest Trees and People Program, Facultad Latinamericana de Ciencas Sociales, Universidad de Valle and the Mayor of Río Hondo.
3. At its simplest, optimal foraging theory states that living organisms forage to maximise the calorie returns to their calories expended. It emerged in an attempt to explain an organism's search for food. From this original conception (MacArthur & Pianka 1966), others have broadened its use to other phenomena in fields such as anthropology, ecology and psychology.

4. IFRI measure erosion in the following manner: 0 if no erosion present; 1 (minor) if surface vegetation and humus layers are absent and the top soil is noticeably looser as a layer; 3 (major erosion) if gullies are present (IFRI 1996: III.A.3- III.A.13).

REFERENCES

Agrawal, A. 2001. Common property institutions and sustainable governance of resources. *World Development* 29(10): 1649–1672.

Agrawal, A. and C. Gibson (eds.). 2001. *Communities and the Environment: Ethnicity, Gender, and the State in Community-Based Conservation*. Rutgers University Press, New Brunswick, NJ, USA.

Ascher, W. 1995. *Communities and Sustainable Forestry in Developing Countries.* Institute for Contemporary Studies Press, San Francisco, CA, USA.

Bailey, R. 1996. Promoting Biodiversity and Empowering Local People in Central African Forests. In: *Tropical Deforestation: The Human Dimension* (eds. L. Sponsel, T. Headland, and R. Bailey), pp 316–317. Columbia University Press, NY, USA.

Baland, J.M. and J.P. Platteau. 1996. *Halting Degradation of Natural Resources. Is There a Role for Rural Communities?* Clarendon Press, Oxford, UK.

Belsky, J. 1999. Misrepresenting communities: The politics of community-based rural ecotourism in Gales Point Manatee, Belize. *Rural Sociology* 64(4): 641–666.

Berkes, F. (ed.). 1989. *Common Property Resources: Ecology and community-based sustainable development*. Belhaven Press, London, UK.

Boserup, E. 1965. *The Conditions of Agricultural Growth*. Aldine, Chicago, USA.

Bromley, D. (ed.). 1992. *Making the Commons Work*. Institute for Contemporary Studies Press, San Francisco, CA, USA.

Gibson, C. 2001. Forest Resources: Institutions for Local Governance in Guatemala. In: *Protecting the Commons: A Framework for Resource Management in the Americas* (eds. J. Burger, E. Ostrom, R. Norgaard, D. Policansky and B. Goldstein), pp. 71–89. Island Press, Washington, DC, USA.

Gibson, C. and C. Becker. 2000. The Lack of Institutional Demand. In: *People and Forests: Communities, Institutions, and Governance* (eds. C. Gibson, M. McKean and E. Ostrom), pp. 135–162. MIT Press, Cambridge, USA.

Gibson, C., J. Williams and E. Ostrom. 2005. Local enforcement and better forests, *World Development* 33(2): 273–284.

Hanna, S., C. Folke, and K.G. Mäler. eds. 1996. *Rights to Nature*. Island Press, Washington, DC, USA.

Harner, M. 1975. Scarcity, the Factors of Production, and Social Evolution. In: *Population, Ecology, and Social Evolution* (ed. S. Polgar), pp: 123–138. Mouton Publishers, Paris, France.

Hayden, B. 1981. Subsistence and Ecological Adaptations of Modern Hunter-Gatherers. In: *Omnivorous Primates* (eds. R.S.O. Harding and G.Teleki), pp. 344–421. Columbia University Press, NY, USA.

Hulme, D. and M. Murphree, eds. 2001. *African Wildlife and Livelihoods*. Heinemann, Oxford, UK.

IFRI. 2004. Proceedings from Global Biennial IFRI Network Meeting in Oaxaca Mexico. Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, IN, USA.

Ilahiane, H. 2001. The Ethnopolitics of Irrigation Management in the Ziz Oasis, Morocco. In: *Communities and the Environment: Ethnicity, Gender, and the State in Community-Based Conservation* (eds. A. Agrawal and C. Gibson), pp: 89–110. Rutgers University Press, New Brunswick, NJ, USA.

International Forestry Resources and Institutions Program. 1996. *Field Manual*. Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, IN, USA.

Johnson, A. and T. Earle. 1987. *The Evolution of Human Societies: From Foraging Group to Agrarian State*. Stanford University Press, Stanford, CA, USA.

Lam, W. F. 1998. *Governing Irrigation Systems in Nepal: Institutions, Infrastructure, and Collective Action.* Institute for Contemporary Studies Press, San Francisco, CA, USA.

MacArthur, R.H. and E.R. Pianka. 1966. On optimal use of a patchy environment. *American Naturalist* 100: 603–609.

McKean, M.A. 1992. Management of Traditional Common Lands (*Iriaichi*) in Japan. In: *Making the Commons Work: Theory, Practice, and Policy (*ed. D. Bromley). Institute for Contemporary Studies Press, San Francisco, CA, USA.

Meinzen-Dick, R., M. Mendoza, L. Sadoulet, G. Abiad-Shields and A. Subramanian. 1997. Sustainable Water Users' Associations: Lessons from a Literature Review. In: *Organizations for Sustainable Water Services, World Bank Technical Paper No. 54* (eds. A. Subramanian, N. Jagannathan and R. Meinzen-Dick), pp. 7–87. World Bank, Washington, DC, USA.

Nature Conservancy. 2007. http://parksinperil.org/wherewework/centralamerica/guatemala/protectedarea/motagua.html.

Netting, R.McC. 1993. *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*. Stanford University Press, Stanford, USA.

North, D.C. 1990. *Institutions, Institutional. Change and Economic Performance.* Cambridge University Press, NY, USA.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge University Press, NY, USA.

Ostrom, E. 1992a. *Crafting Institutions for Self-Governing Irrigation Systems.* Institute for Contemporary Studies Press, San Francisco, CA, USA.

Ostrom, E. 1992b. The Rudiments of a Theory of the Origins, Survival, and Performance of Common-property Institutions. In: *Making the Commons Work: Theory, Practice, and Policy (*ed. D. Bromley). Institute for Contemporary Studies Press, San Francisco, CA, USA.

Ostrom, E. 1998. The International Forestry Resources and Institutions Research Program: A Methodology for Relating Human Incentives and Actions on Forest Cover and Biodiversity. In: *Forest Biodiversity in North, Central and South America, and the Caribbean: Research and Monitoring* (eds. F. Dallmeier and J.A. Comiskey). UNESCO and The Parthenon Publishing Group, NY, USA.

Ostrom, E., R. Gardner and J.M. Walker. 1994. *Rules, Games, and Common-Pool Resources.* University of Michigan Press, Ann Arbor, USA.

Ostrom, E. and M. Wertime. 1994. International Forestry Resources and Institutions (IFRI) Research Strategy. Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, IN, USA.

Stephens, D.W. and J. R. Krebs. 1986. *Foraging Theory.* Princeton University Press, Princeton, NJ, USA.

Wade, R. 1994. *Village Republics: Economic Conditions for Collective Action in South India*. Institute for Contemporary Studies Press, San Francisco, CA, USA.

Winterhalder, B. 1981. Optimal Foraging Strategies and Hunter-Gatherer Research. In: *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses* (eds. B. Winterhalder and E. Smith), pp. 13–35. Chicago University Press, Chicago, USA.