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Multi-Scale Forest Governance, Deforestation, and Violence in Two Regions of Guerrero, Mexico

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Summary. — It has been suggested that weaknesses in rights and land tenure is one of the important causes of forest-related violence. We go beyond rights and tenure to examine relationships between deforestation, forest-related violence, and multi-scale forest governance in a situation of secure tenure rights in comparative case studies of four communities in two watersheds in Guerrero, Mexico. Multi-scale forest governance influenced different rates of land use/cover change and lethal violence but cattle and human population are also influential. We suggest that weaknesses at the regional level of forest governance can be compensated by strong national and community governance.

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Key words — common property, community forest management, forest-related violence, LUC analysis, Latin America, Mexico

1. INTRODUCTION

(a) *Deforestation, conflicts and violence*

There has been increased attention to relationships between deforestation and various forms of forest-related conflict and violence in recent years (Alston, Libecap, & Mueller, 2000; de Jong, Donovan, & Abe, 2007; De Koning, Capistrano, Yasmi, & Cerutti, 2008; Price, 2003). Increases in global forest-related conflict have made the issue an emerging priority (FAO, 1996; Means & Josayma, 2002; UN, 2004). Forest-related violence can include guerrilla wars, drug cultivation, and refugee flows into forests and in varying circumstances can be a driver of either deforestation or conservation (de Jong et al., 2007; Draulans & Van Krunkelsven, 2002; O'Brien, 1998; Price, 2003), so the relationship between forest cover processes and these variables is not clear. Several studies have analyzed the relationship between high percentages of national forest cover loss, authoritarianism, and high levels of class inequality, but no linear relationship has been found (De Koning et al., 2008). In another study, high rates of deforestation are correlated with low-intensity conflicts, but not with larger scale armed conflicts (Hauge & Ellingsen, 1998), arguing against an “ecoscarcity” model of deforestation (Homer-Dixon, 1999).

Despite this documented complex association between violence and deforestation, most meta-analyses of deforestation do not take violence into account. Significant advances have

been made in distinguishing region-specific proximate and underlying causes of deforestation (Geist & Lambin, 2001) or more generally, “conjoint causation with multiple, interacting causes in specific places” (Rudel, 2005). Proximate causes commonly include logging, road building, and expansion of crops and pasture for cattle, while underlying causes may be macroeconomic policy or demographic pressures. As well, conjoint causation is dynamic, can shift over time, and is specific to world regions. A dominant causal constellation in one period may yield in a later period to “more varied trajectories of land use change,” including processes of forest recovery (Rudel, 2005). Rudel calls the historically grounded form of analysis that can trace these variations “event ecology.” Thus, we regard forest-related violence as one of the historically grounded events bound up with deforestation. Depending on

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the specific event ecology of a particular region, it may be one of the conjoint causes of deforestation, or it may be an example of multifinality, or what we may call conjoint consequences, when more than one outcome (e.g., violence and deforestation) is consistent with a particular value of an independent variable or variables (George & Bennett, 2005).

In order to better understand relationships between particular causes and consequences that include violent conflict and deforestation it is important to distinguish levels of conflict. Two broad classifications may be distinguished: (1) more intense conflicts ranging from war with opposing organized armies, with a minimum of 1,000 battle-related deaths, to armed conflicts of more diverse kinds with a threshold of 25 battle-related deaths per year and (2) low-intensity conflicts which may include non-state conflicts between two groups and one-sided violence such as massacres by states or other organized groups (De Koning et al., 2008; Richards, Wells, Del Gatto, Contreras, & Pommier, 2003). In low-intensity conflicts, which we will be focusing on here, there can be much confusion about the exact numbers of deaths attributable to different causes, making official homicide records unreliable (Gutiérrez, 2004; Lewis, Dobash, Dobash, & Cavanagh, 2003).

De Koning et al. (2008) propose that variables of “institutional quality” in forest governance or what we will call robust institutions (Anderies, Janssen, & Ostrom, 2004) are important factors, but argue that the institution of secure property rights may be the most important independent variable that influences both violence and deforestation. For example, one study found a highly significant effect between insecurity of ownership and high rates of deforestation in 62 countries (De Koning et al., 2008), while a previously mentioned review found that high deforestation correlates with low-intensity conflicts (Hauge & Ellingsen, 1998), suggesting associations between the absence of robust institutions and property rights, deforestation and low-intensity conflict. In order to explore more contextually some of the relationships suggested in these large N studies, we turn to systematic comparative case studies and multiple methods of “process-tracing” (George & Bennett, 2005), similar to Rudel’s (2005) “event ecology,” as well as statistical analysis. Our case studies are from forest communities in the Mexican state of Guerrero. Mexico, in general, has secure property rights for community forests, (Bray, Durán, Merino-Pérez, Torres-Rojo, & Velázquez, 2007) which allows us to hold constant property rights and examine the influence of other institutional issues. Multi-scale governance has been proposed as a set of institutions which can improve resource management in multiple dimensions (Berkes, 2007). We thus find evidence for a relationship between “multi-scale governance” as an independent variable and deforestation and violence as conjoint outcomes in a comparison of four paired communities in two watersheds (Coyuquilla and Tecpan) in the Pacific Coast state of Guerrero in Mexico, although there are also clearly other mitigating factors.

Multi-scale forest governance was considered as the total set of government and civil society institutional partnerships, both formal and informal, which have decision-making power or influence over forest management (Berkes, 2007). At the local, community scale, research has placed particular emphasis on local monitoring and enforcement of rules as key variables influencing the conditions of forest commons (Chhatre & Agrawal, 2008; Gibson, Williams, & Ostrom, 2004). In Mexico, forest governance institutions and organizations can be analyzed at three scales, the community scale, the regional scale, and the national scale. Mexican communities have mandated governance structures composed of assemblies of

all legal members that elect their authorities. This agrarian governance structure has frequently been transformed in innovative ways in order to administer community forest enterprises (CFEs) (Antinori & Bray, 2005). CFEs frequently have organized (both with their own efforts and with external actors) into inter-community or second-level associations for multiple purposes, a second scale of governance. The federal environmental agency, the Secretary of the Environment and Natural Resources (SEMARNAT) regulates forest extraction through the granting and monitoring of logging permits based on management plans, and constitutes a third scale of forest governance (Bray et al., 2007).

The study case was found opportunistically (George & Bennett, 2005), because both watersheds appeared to exhibit many similarities but important variances on the outcomes of violence and deforestation. Based on our prior research and reports on the region, we hypothesized that community level governance failures with respect to forest management had led to high deforestation and lethal violence in the Coyuquilla watershed, and that the presence of robust community forest management institutions in the Tecpan watershed was associated with low deforestation and violence. What we found was more complicated, and led us to the new hypothesis, that it is failures in particular levels of multi-scale governance that can lead to deforestation and violence in a context of secure property rights.

(b) *Deforestation and violence in Mexico*

Mexico has lost half of its original forest coverage and current deforestation rates were considered among the highest in the world (FAO, 1996; Velázquez et al., 2002), although they declined in recent years. However, community forest governance in some regions is associated with very low deforestation rates and forest recovery (Bray, Ellis, Armijo, & Beck, 2004; Durán, Mas, & Velázquez, 2005; Ellis & Porter, 2008). The integration of CFEs with other scales of governance is uneven, and there many other examples in Mexico where violent conflicts and weaknesses at multiple scales of governance are associated with guerrilla movements, illegal timber extraction, forest degradation, and deforestation (Brower et al., 2002; Gutiérrez 2004; O’Brien, 1998).

Individual homicides, and forms of mass homicides such as massacres, are taken as an indicator of forest-related conflict. Mexico has on average higher rates of homicides in rural areas that have been associated with electoral competition, unequal land distribution, cash crops such as coffee and cattle, and remoteness (more distant from government institutions). A higher percentage of homicides also happened on community lands, but it is highly relevant to note there are fewer homicides where there are high levels of organization (Villarreal, 2002, 2004). Guerrero has a particular reputation for generalized violence, with a homicide rate that is twice the national average (Villarreal, 2004). The so-called Costa Grande of Guerrero (the coast north of Acapulco, Figure 1) is particularly notorious for very high levels of violence by multiple actors related with boundary disputes, illegal logging, drug cultivation, state violence, and guerrilla uprisings protesting government policies, many of which are related to forests as resource or setting (Bartra, 1996; Gutiérrez, 1998). Recent historical outbreaks of forest-related violence in the Costa Grande include a 1995 massacre by state police of 17 peasants protesting illegal logging in their community at the *Aguas Blancas* river crossing in the municipality of Coyuca de Benitez. On the first anniversary of the massacre a new guerrilla movement, the Popular Revolutionary Army (Ejército

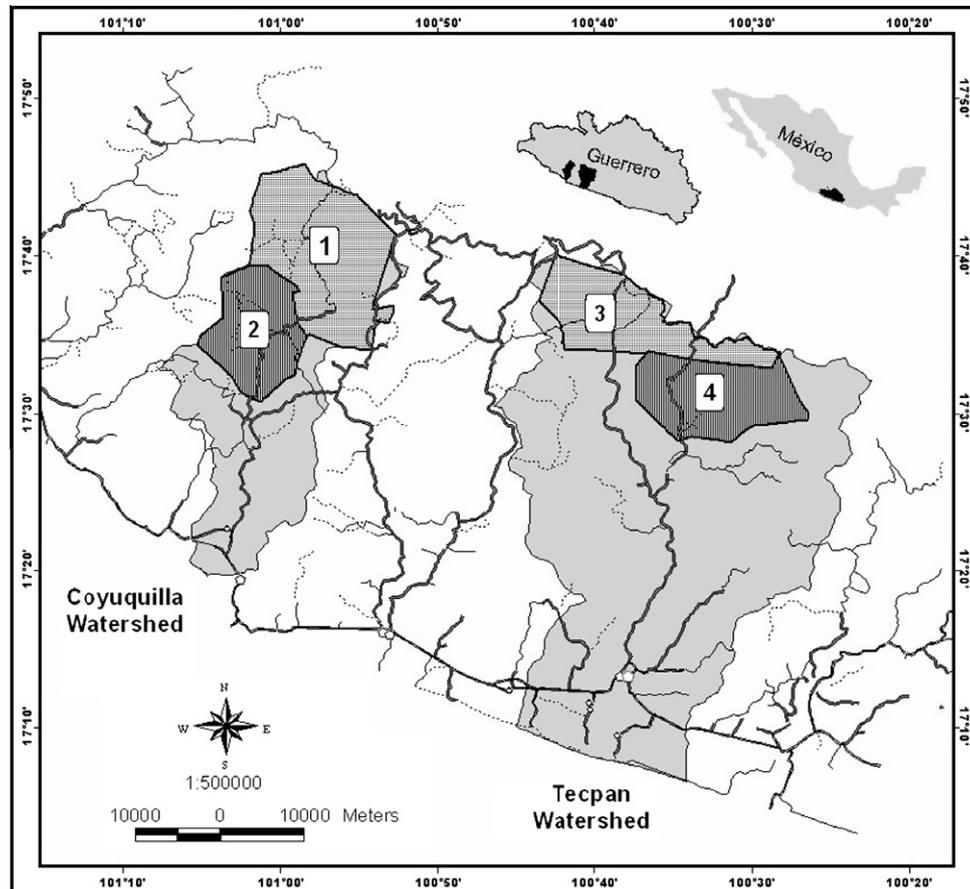


Figure 1. Location of the two watersheds studied in the Costa Grande of Guerrero state in Mexico and of the study communities (*ejidos*). (1) The community of Corrales; (2) Mameyal; (3) Cordon Grande and (4) Platanillo.

Popular Revolucionario) went public (Fox, García-Jiménez, & Haight, 2009), an armed movement inspired among other reasons by forest conflict.

Also in 1996, another movement known as the “ecologist peasants,” one of the subjects of this study, emerged in the Cuyuquilla watershed in Petatlán municipality, protesting perceived high levels of deforestation caused by logging controlled by local political bosses (*caciques*) and the timber transnational Boise Cascade. The movement was sparked by the (temporary) incursion of the foreign timber company into local logging operations, a common source of local-level conflict (De Koning et al., 2008). This movement subsequently became immersed in forest-related killings, with most reported victims among the ecologist peasants, but also local leaders opposed to them, soldiers, and others. There were also accusations of relations between the ecologist peasants, the guerrilla movement, and drug cultivators and traffickers, making attributions of causes of homicide difficult (Gutiérrez, 1998). Very high rates of deforestation were also reported, with one official study claiming that 40% of the forest in the region had been lost from 1992 to 2000 (CONABIO, 2002; McKinley, 2005). However, the same region has also been found to have large areas of intact forests (Brandon, Gorenflo, Rodrigues, & Waller, 2005), a contradiction to which we will return.

In a notable contrast to forest-related violence in this region, in the upper watershed of the Tecpan River, geographically located between the scenes of the *Agua Blanca* massacre and the ecologist peasants movement, research has found robust community and forest governance institutions in the form of

community assemblies, CFEs, and an inter-community organization, the Hermenegildo Galena *Ejido* Union (HG-Union) (Torres-Rojo, Guevara-Sanginés, & Bray, 2005). There has also been no reported fatal violence during the same period in the HG-Union, despite the fact that in the 1980s and earlier, these communities had numerous homicides connected to boundary disputes (Bray & Merino-Pérez, 2003).

2. METHODS

(a) Study area

The study area is located in the Costa Grande of Guerrero state, Mexico (Figure 1), and includes four paired communities in two watersheds, the Cuyuquilla River watershed (59,362 ha), Petatlán municipality, and the Tecpan River watershed (154,884 ha), Tecpan de Galeana municipality.

The two study watersheds extend from the ridgeline of the Sierra Madre del Sur (*ci.* 2,200 m above sea level) and flow towards the Pacific Ocean. They are broadly similar in their biophysical characteristics and land use histories. Forest cover is very similar, with heavily fragmented tropical forests in the mid-elevations and larger masses of pine and oak forests in the upper elevations. The study communities at the mid-altitude range (>500 to 1,000 m) were El Mameyal (Mameyal), in the Cuyuquilla watershed, paired with El Platanillo (Platanillo), in the Tecpan watershed. At the upper range (>1,000 m) the paired communities were Corrales in Cuyuquilla and

Cordón Grande in Tecpan (Figure 1). All communities were settled in the first half of the 20th century through spontaneous colonization by non-indigenous settlers and obtained land grants from the 1940s to the 1960s. All communities, until the 1990s, managed their forests through CFEs that began operating in the 1970s and 80s, while one (Mameyal) ceased operating in 1997. In a multiple methods approach, we combined land use cover change (LUCC) analysis, with a statistical analysis of the governance and other variables, and process-tracing of events in the study communities.

(b) Land use cover change analysis

The LUCC analysis in both watersheds was based upon two data sets. The first was series I from the National Institute of Geography, Statistics, and Informatics (INEGI) taken during the year 1979 by aerial photography, and verified by ground-truthing at over 10,000 sites nationally. The second was derived from 2,000 landsat ETM7 images (Velázquez et al., 2002), as the main source for land cover delineation, and tested for reliability by comparison with a sample of aerial photographs taken in the same year (Mas et al., 2004). For this study, data bases were verified in 2004–5 during four field trips. We looked at shifts in categories of land use/forest cover over the 1979–2000 period, analyzing first changes in “undisturbed forest,” “disturbed forest”, and “anthropogenic” uses, and second, changes in “temperate forest,” tropical forest”, and “anthropogenic uses.” In both cases, the anthropogenic use category included crops, induced pasture, and human settlements (Velázquez et al., 2003). In order to calculate and represent deforestation rates in LUCC maps, four types of changes were computed: deforestation, disturbance, recovery, and revegetation (Velázquez et al., 2003). All data handling was conducted with Arcinfo, 8.1 version and change rates computed as indicated in Puyravaud (2002).

(c) Governance indicators

Data on forest governance in the Tecpan watershed was obtained from many trips over more than a decade and specific data for this study was obtained in four 1- to 2-week trips to both watersheds in 2004–5. Informal, semi-structured, and structured interviews were applied to community leaders and farmers from the four communities and leaders of the ecologist peasants and second-level organizations. Interviews included data on size of commercial forest, number of livestock, and governance such as regularity of assembly meetings, presence of functioning CFEs, clandestine logging, written rules, second-level organizations, and monitoring and enforcement of rules governing forests. At the federal scale of governance we used the existence and in some cases, suspension and reinstatement of logging permits, as indicators of effective governance. Population data was obtained from a 2005 Guerrero state demographic census (INEGI, 2005). For

homicides, we combined the interviews with official statistics and newspaper reports. We examined official statistics on homicides at the municipal level from 1996 to 2002 at <http://www.inegi.org.mx> and were provided information from the homicide database of Prof. Andres Villareal (personal communication). We also examined accounts of violence and homicides in one national and one regional newspaper known for their coverage of rural issues (*La Jornada* www.jornada.unam.mx and *El Sur* of Acapulco www.suracapulco.com.mx).

(d) Statistical analysis

For the statistical analysis we looked only at the relationship between multi-scale forest governance and deforestation, since we did not have sufficient data on violence to include it, and it is handled qualitatively as a conjoint outcome. A forest governance index for each community was estimated based on 11 multi-scale institutional variables combined or directly taken from Table 2. We used binomial values of 1 for good governance and 0 for weak or in-existent governance. Using the forest governance indexes and the respective deforestation rates for each community a Pearson correlation index was estimated (Zar, 1980). In addition we used 26 demographic, economic, and institutional indicators (taken from Tables 1 and 2) to conduct a multivariate analysis (Detrended Correspondence Analysis) to distinguish similarities among communities along ordination axes (ter Braak, 1986). Criteria for transformation of variables used the following principles: if the original value was numeric it remained the same, if the variable was a proportion it became a coefficient, if the variable was an ordinal value it became an absolute value, and if the variable was nominal it became binomial. The ordination biplot resultant illustrated the relationship among variables and communities along the axes.

3. RESULTS

(a) Land use cover change analysis

To understand the context of forest cover processes at the community level, we briefly mention findings at the level of each entire watershed. By 1979 undisturbed forest was already reduced in both watersheds, to 42% in Coyuquilla, while 58% remained in Tecpan. From 1979 to 2000, both basins went through a dramatic expansion of anthropogenic land uses, with agriculture and cattle pasture increasing from 28% to 45% of the land surface in Coyuquilla and from 12% to 32% in Tecpan. The annual deforestation rates for the watersheds were similar, -1.3% in Coyuquilla and -1.2% in Tecpan. Regarding the forest types lost, the Coyuquilla watershed deforested 7% of its temperate evergreen commercial forest (-0.73% annual deforestation), while Tecpan lost only 2% (-0.20%). Annual rates of loss of tropical forest, both mon-

Table 1. Basic comparative data on demography, land use and homicides in the two watersheds and the four study communities

Watershed characteristics	Coyuquilla		Tecpan	
	Corrales	El Mameyal	Cordón Grande	El Platanillo
Date of community establishment	1945	1959	1959	1967
Total area (ha)	23,279	12,430	15,093	14,469
Common property forests (ha)	4139	1200	2655	1927
Population density (person:ha)	1:151	1:27	1:62	1:71
Cattle density (cow:ha)	1:12	1:3	1:15	1:36
Number of forest-related homicides by watershed (1996-2002)	7		None	

Table 2. Multi-scale governance variables in the four study communities. FM = forestry management, WR = water reservoir, GP = governmental programs, FF = fire fighting, SI = social issues

Governance level	Governance indicators	Watershed Coyuquilla		Watershed Tecpan	
		Corrales	El Mameyal	Cordón Grande	El Platanillo
Local	Forest land parceled for grazing	Yes (informally)	Yes (informally)	No	No
	Conservation in forestry areas	Yes	No	Yes	Yes
	Conservation in riparian zone	Yes	Yes	Yes	Yes
	Wildlife protection	No	No	Yes	Yes
	Forest monitoring	Yes	No	Yes	Yes
	Monthly general assemblies (% of participation)	Yes ($\geq 50\%$)	No ($\approx 35\%$)	Yes ($\geq 75\%$)	Yes ($\geq 50\%$)
	Extraordinary assemblies per year (% of participation)	3 ($\geq 50\%$)	None	8 ($\geq 50\%$)	1 ($\geq 50\%$)
	Issues discussed	FM, WR, GP	WR	FM, FF, SI	FM, FF
	Written regulations	Yes	No	Yes	Yes
	Sanction exist	No data	No	Yes	Yes
Community forest enterprise	Yes (logging permit suspended, 1998–2004)	No (logging permit canceled in 1998)	Yes	Yes	
Regional	Inter-community organization	Yes	Yes	Yes	Yes
	Organization influence in forestry	Weak to none	Weak to none	Strong	Strong
National	Suspension of logging permits	Yes	Yes	No	No
	Reinstatement of logging permits	Yes	No	–	–

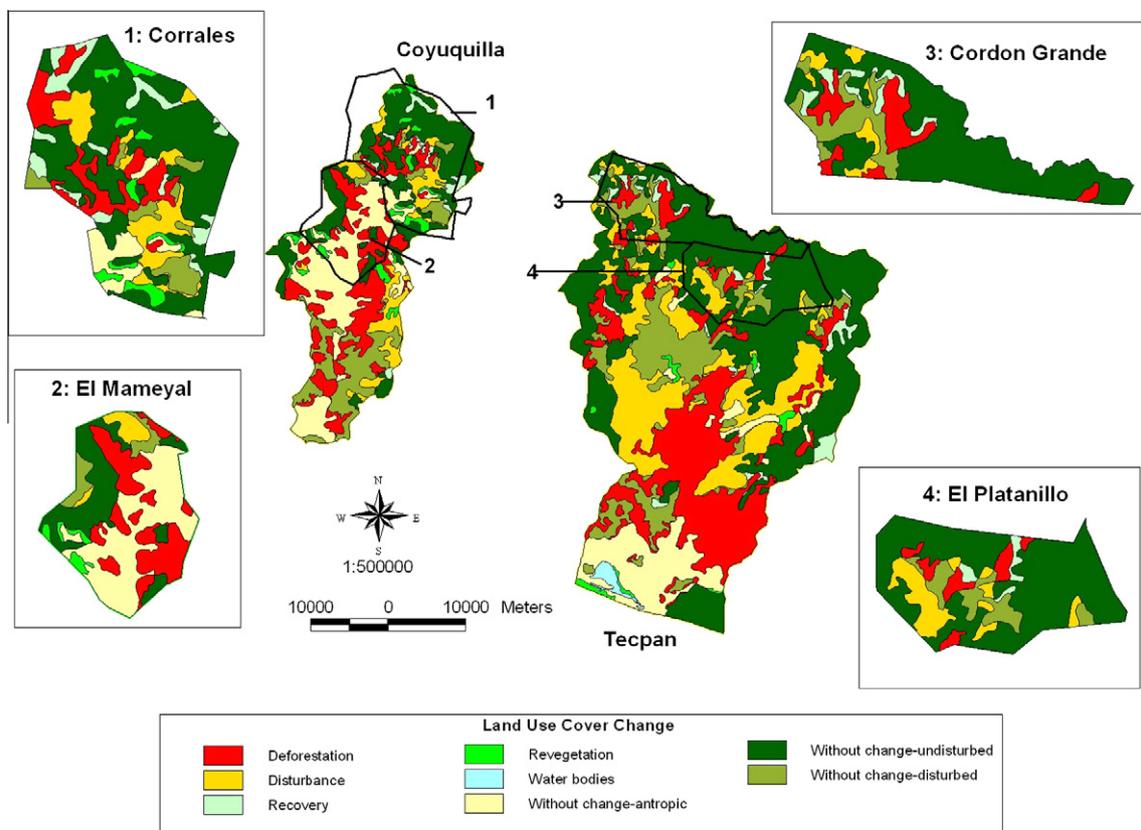


Figure 2. Land use cover change maps at the watershed (Coyuquilla and Tecpan) and community (Corrales, Mameyal, Cordon Grande, Platanillo) scales, 1979–2000, Costa Grande of Guerrero, Mexico.

tane tropical and dry forest on the lower slopes, were much higher, -2.89% in Coyuquilla and -2.94% in Tecpan. Each watershed lost in 21 years about half of the tropical forest they had in the late seventies.

From the LUCC maps depicting these watershed scale changes (Figure 2), it can be seen that deforestation (in red) in Tecpan occurred in large blocks mostly in the lower parts of the watershed, in tropical dry forest, and in much smaller

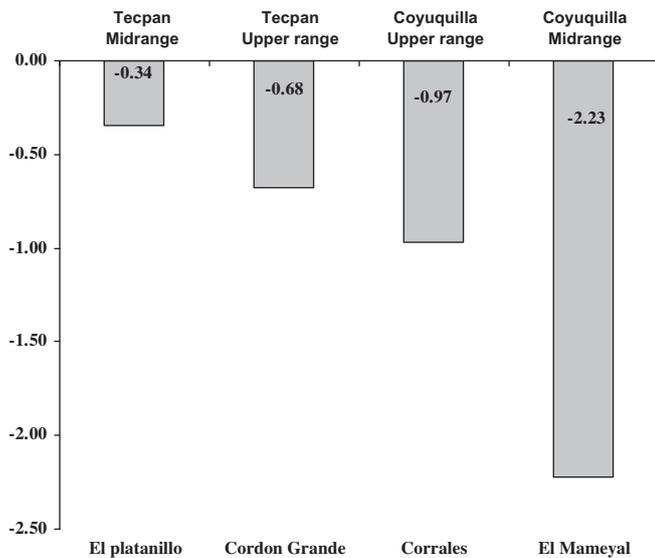


Figure 3. Annual deforestation rates in the study communities by watershed, during period 1979–2000.

areas scattered in the upper part. Deforestation followed a much more scattered pattern in the Coyuquilla watershed. In both watersheds intact pine and oak forest masses (dark green) are found in the upper elevations of the watershed.

At the community level, Platanillo, in the Tecpan watershed, had the lowest deforestation rate of any of the communities at -0.34% . Mameyal, on the other hand, had a -2.23% annual deforestation rate. Comparing the upper slope communities in each watershed, we find that Cordon Grande had a deforestation rate of -0.68% while Corrales showed a slightly higher rate at -0.97% (Figure 3).

The LUC maps also show that deforestation in the Tecpan communities was concentrated in one area of each community's territory, a probable result of the land use zoning in forest management plans. In Corrales, deforestation was somewhat more diffuse, but in Mameyal deforestation occurred throughout the territory of the community (Figure 2). Further, the LUC maps show significant areas of forest recovery (light green in Figure 2)¹ in the two Tecpan communities and Corrales, but none in Mameyal.

(b) Analysis of multi-scale governance and violence

Table 2 shows the variables used in the analysis of multi-scale governance. All communities have common property forests, but in the Coyuquilla watershed, both communities informally parceled their forests for livestock grazing, although the trees were retained as common property. Both the Tecpan communities maintained their forests as unparceled common property under the control of the community assembly and the CFE. However, in almost all of the other community indicators, the profile of Corrales is the same as the two Tecpan communities. It is particularly notable that all three communities have forest monitoring, written regulations, and two of them have sanctions (we did not obtain this data for Corrales). There are, however, significant differences at the regional and national level. At the regional governance scale, in the Coyuquilla watershed, an extremely weak second-level organization existed with virtually no influence over forest management. In the Tecpan watershed, a robust and effec-

tive inter-community organization with strong influence on forest management and governance has existed since the 1980s.

At the federal scale, both Mameyal's and Corrales' logging permits were suspended by the federal environmental agency in 1998, in the midst of an eruption of violence, guerrilla and military activity, and the rise of the ecologist peasant movement protesting illegal logging. However, in 2000, an audit by Mexico's environmental agency found that negative impacts of logging in Corrales "cannot be considered serious" (our translation) and a logging permit was reinstated in 2004. Mameyal's logging permit was permanently canceled, concluding that "in this community... the forest frontier is constantly diminishing in accelerated steps, to extend cattle pasture for extensive livestock raising or for agriculture" (our translation); (SEMARNAP/PROFEPA, 2000). The two Tecpan CFEs have continued logging mostly uninterrupted since the mid-1980s. The Pearson index found a high and significant correlation between the forestry governance index and deforestation rates ($r = -0.98$) and the correlation with population size and deforestation rates was also high ($r = 0.87$). The multivariate analysis output resulted in low eigenvalues (axis I [$\lambda = 0.006$] and axis II [$\lambda = 0.001$]) showing that variables included accounted for a small proportion of the variance. The placing of the communities and their relationship with variables, nevertheless, was notable with Mameyal clearly split from the rest and strongly associated to cattle density. Corrales, on the other hand, was placed significantly away from Mameyal along axis I and correlated to the occurrence of extraordinary assemblies where forest management issues were discussed. Platanillo and Cordon Grande were clearly away from Mameyal along axis II and related to the occurrence of extraordinary assemblies where social issues were discussed. No further conclusions were yielded because of the weakness of the axes' eigenvalues.

With respect to homicides, official statistics are gathered at the level of the municipality, which is not a unit of analysis here, but they show little difference between the municipalities which include the two watersheds, and motives are not recorded. However, the examined newspaper reports and interviews in the regions suggested that the Coyuquilla watershed had a notably higher incidence of lethal violence and conflicts related to mixtures of the ecologist peasant movement, drug trafficking, guerrillas, and the military. An examination of the newspaper reports of violence in the two regions for the 1996–2002 period showed 18 killings in the Coyuquilla region and none reported for the upper Tecpan watershed, with the relative incidences confirmed by interviews. Of the 18 killings, newspaper accounts tied 7 of them specifically to forest-related conflict

4. DISCUSSION

Contrary to our original hypothesis of widespread forest governance failures, deforestation, and violence in the Coyuquilla watershed, similar to many other regions of Guerrero, we found that only one of the two communities conformed to our expectations. We did find in the Tecpan communities the expected associations between multi-scale governance and low deforestation and violence. In Mameyal, we found that weakness in multi-scale governance was associated with deforestation and violence, while in Corrales governance was stronger, deforestation was lower, and lethal forest-related violence was absent, although a greater tendency toward greater forest fragmentation than in the Tecpan communities

does suggest some weakness in forest governance. But it was also clear that cattle density and higher population, statistically associated with Mameyal, were also strongly associated with deforestation.

The explanation of the varying outcomes between the community of Mameyal and the other three case studies communities requires process-tracing to examine the impacts of historical social processes on different forest cover outcomes, in addition to the systematic case study comparison carried out above (George & Bennett, 2005; Rudel, 2005). The deviant case of Mameyal can be explained in part by its historical path dependency. The community was settled by workers in a large commercial forest operation in the Coyuquilla watershed in the 1940s and 1950s, and adopted small-scale cattle ranching from the very beginning. It thus was founded with a larger population than other communities in the region, and one that could use wages to invest in cattle, a common driver of deforestation in Mexico (Durand & Lazos, 2004) and elsewhere in the tropics. All the other three study communities were formed by subsistence corn farmers immigrating from other regions, with more reduced dependence on cattle. By the 1990s this historical pathway in Mameyal had already led to extensive loss of forest cover because of small-scale cattle ranching, not logging, and domination by a small group of political bosses (*caciques*) who reportedly carried out small-scale illegal logging in the remaining forest by cutting more than the permits allowed for personal profit. The presence of widespread cultivation of drugs and the emergence of the Popular Revolutionary Army (guerrilla movement) in the 1990s further complicated matters. The emergence of environmentally radical community members in Mameyal, the ecologist peasants, in this context drove the principal actors to brief national and international prominence (Bartra et al., 2000; Dillon, 2000; McKinley, 2005). The putative leader of this movement, Rodolfo Montiel, was awarded the Goldman Environmental Prize and the Sierra Club's Chico Mendes prize while in jail on drug and firearms charges in the late 1990s. The ecologist peasants were firmly grounded in a long history of struggle against corrupt logging in the Costa Grande of Guerrero and were aware of state responses such as the earlier mentioned massacre at *Aguas Blancas* (Bartra, 1996). Nonetheless, they also had little knowledge that better-governed community logging was occurring even in neighboring communities, assuming that the same corruption and forest degradation they were seeing in their own community was everywhere the norm.

Our findings on deforestation in the Coyuquilla watershed also allow for a correction of the historical record on this subject. The ecologist peasants' accusations of widespread deforestation was reinforced by the previously mentioned finding that 40% of the region was deforested during 1992–2000 (CONABIO, 2002; McKinley, 2005), based on a study carried out by National Commission for the Knowledge and Use of Biodiversity (CONABIO). By contrast, our results show 18% forest loss over a 21-year period in the Coyuquilla watershed and that the forest loss is heavily concentrated in the non-commercial tropical forests on the lower slopes of the watershed (Figure 2), strongly suggesting that it was small-scale cattle ranching and not logging that drove deforestation in the region. Our examination of the CONABIO analysis also reveals serious methodological errors which included using an image of a much larger area than the Coyuquilla watershed, images from two different seasons (deciduous forest during the dry season was interpreted as deforestation), and no ground-truthing (CONABIO, 2002). We believe our data present a more

accurate picture of deforestation in the region. Nonetheless, the unique confluence of circumstances and the perception of deforestation in Mameyal led to a social explosion with local, national, and international consequences, and created an image of out-of-control logging for the entire watershed, contributing to the outcome of violence.

In the Tecpan communities, the consistent indicators of good forest governance at the community scale, including parceling of the forest for cattle, regular, and extraordinary assemblies with quorums focused on forest management, written rules, and monitoring and sanctioning based on those rules, continuously functioning CFEs, and other indicators of robust forest governance institutions, would appear to be related to their participation for over 20 years in the second-level HG-Union, as a second scale of governance. Historical process-tracing in these communities shows a documented history of extreme violence, much of it reportedly over land, with one HG-Union community reporting 18 widows from this period (Bray & Merino-Pérez, 2003). The HG-Union then arose in the 1980s promoted by rural union organizers, and one of their first accomplishments was to settle land disputes between neighboring communities (Torres-Rojo et al., 2005). This successful conflict resolution led to a pattern of cooperation and collective action which has continued to this day, including a dramatic reduction in violence. Thus a baseline of violence can be established, followed by the emergence of institutions of collective action around forest management, and a current stage of civil peace within these communities. When negative events happen, recovery is quick. For example, Cordon Grande did not log in 2005 because a community leader absconded with CFE funds. Nonetheless the robustness of the institutions were demonstrated when logging was resumed in the following year with no associated violence.

Our findings on multi-scale governance allow us considerable precision on where the weaknesses lie. We found in the Tecpan watershed three scales of forest governance functioning: community, regional, and federal government scales all work well by our indicators, with deforestation low and local lethal violence absent. In the Coyuquilla watershed, the regional level of governance is mostly missing. But Mameyal is also missing effective community level forest governance institutions while Corrales has them. This suggests that when at least two levels of governance are functioning, as in the federal and community levels in Corrales, this can mitigate violence and deforestation even when a regional scale of governance is missing. However, when two levels of governance are missing, as in Mameyal, deforestation and violence may be conjoined outcomes. Villarreal's (2002, 2004) research suggesting that communities with higher levels of organization have lower homicides also supports this interpretation with reference to violence.

However, in the case of Mameyal, as indicated, associations with density of cattle and the size of the human population (and it also has the smallest forest) suggest that it is a case where multiple conjoined causes have resulted in the referenced outcomes. Much of the deforestation also likely took place in earlier periods, even before forest management for timber was an option so the capacity for community forest governance was already quite weak. Nonetheless, the experience in Tecpan suggests that if an effective second-level organization had been able to emerge in Coyuquilla, combined with the existing federal regulation, it could have helped to mitigate some of the tensions arising from the Mameyal-based ecologist farmers movement and illegal logging in the community. This in turn, draws attention to the phenomenon

of inter-community collective action, which seems particularly common in Mexico around timber production (Torres-Rojo et al., 2005). The incentives for collective action around timber production at the community and inter-community level are substantial when it can improve incomes and technical assistance. These may be considered modern and innovative institutions for inter-community governance (Paudel, Monterroso, & Cronkleton, 2010), with multiple benefits, including violence reduction.

5. CONCLUSION

De Koning et al. (2008) argue that the absence of tenure and property rights, including ownership of forest land and resources, is an important source of forest-related conflicts, but also note that it is difficult to prove that community-based rights to resources can lead to more “social tranquility.” Gibson et al. (2004) argue that it is community-based institutions such as monitoring and sanctions that are most relevant for positive forest outcomes. However, it has also been recently argued that frequently the strengthening of local rights to forests and community governance is not in itself sufficient to guarantee improved forest management, if broader institutional elements are not also in place (Larson, Barry, Dahal, & Colfer, 2010). This case study research of communities with relatively secure property rights suggest an expansion of these hypotheses on relationships between property rights, community governance, improved forest management, and low-intensity violence. We suggested that rights and governance need to be reinforced at multiple scales, that multi-scale governance through networks and partnerships is a specific governance form which may mitigate low-intensity violence and deforestation in other global situations (Berkes, 2007; Hauge & Ellingsen, 1998). Our case studies also suggest that multiple scales of governance over forest resources may be most effective in conditions of low dependency on cattle ranching, and relatively low populations. Where the latter two variables are higher, pressures

on both forest resources and the capacity to govern them may be challenged. Further, where regional scales of governance are weak or missing, strong community and national governance can compensate, but the presence of all three scales can lead to optimal forest outcomes.

More broadly, what may be called the “community forest hypothesis” states that local control of forest resources can reduce deforestation and alleviate poverty. It has been shown in particular for Mexico that community forest management for commercial timber production in Mexico can achieve these ends (Bray et al., 2007; Durán et al., 2005; Ellis & Porter, 2008). The research presented here suggests that under certain specified conditions, robust institutions for community forest management for timber can also reduce forest-related violence. We suggest that this hypothesis merits further exploration in other cases and larger N samples. The emergence of community forest management for timber elsewhere in Latin America, Africa, and Asia suggests that the lessons from this study could have broad application.

Indeed, this research also reinforces the proposal that Mexican community forestry, at its best, may present a model for global forest governance that can achieve multiple benefits and, of particular interest here, positive outcomes in relation to forest-related violence (Agrawal, Chhatre, & Hardin, 2008; Bray, Antinori, & Torres-Rojo, 2006). In the Tecpan watershed and elsewhere in Mexico, there have been significant advances in crafting effective forest governance institutions at multiple scales (Rudel, 2005). Globally, there has been ongoing, although highly uneven, devolution of rights over forests to local communities (Molnar, Scherr, & Khare 2004; Sunderlin, Hatcher, & Liddle 2008). Our findings suggest that policies that give communities access to timber rights in forests may be one of the most important rights that can be granted. These rights should be reinforced by external support in building regional governance organizations for technical assistance that can be linked with strengthened national forest governance structures (Larson et al., 2010).

NOTE

1. For interpretation of color in Fig. 2, the reader is referred to the web version of this article.

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