Citizen monitoring promotes informed and inclusive forest governance in Liberia

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Global forest loss depends on decisions made in the rural, often poor communities living beside the Earth's remaining forests. Governance problems in these forest-edge communities contribute to rapid deforestation and household vulnerability. In coordination with experimental studies in 5 other countries, we evaluate a program that recruits, trains, and deploys citizens to monitor communal forestland in 60 communities in rural Liberia. The yearlong intervention is designed to promote more informed and inclusive resource governance, so that that citizens' preferences (and not just leaders' interests) are reflected in forest management. In our control communities, households are uninformed and disengaged; leaders' authority is unchecked. The program both engages and mobilizes community members: households are better informed and participate more in the design and enforcement of rules around forest use. They also report receiving more material benefits from outside investors' activities in their community forests. The chiefs who lead these communities attest to strengthened accountability. Using both on-the-ground environmental assessments and remotely sensed data, we find no effects on forest use or deforestation. Households do not favor more conservation, and, thus, more inclusive management does not reduce forest use. Conservation likely requires compensating community members for foregoing forest use; citizen monitoring, we argue, could ensure that such schemes enjoy popular support and do not just benefit local elites.

resource governance | citizen monitoring | social accountability | forest conservation

Forest conservation promotes biodiversity and mitigates climate change (1). Conservation depends on decisions made in the rural communities in middle- and low-income countries located beside the Earth's remaining hardwood forests (2). Decisions made in these forest-edge communities often result in significant deforestation.

Past work identifies two governance problems that can contribute to deforestation. First, in many contexts, forests are common pool resources. Community members may deplete these commons, because they do not internalize the costs their overuse imposes on neighbors or future generations (i.e., due to a "common pool problem") (3). Second, power may be concentrated in a small number of elites, who garner the benefits from external agribusiness or logging operations (4, 5). Large-scale commercial agriculture accounted for 40% of tropical deforestation between 2000 and 2010 (6). Elite capture could result in clearing that exceeds what constituents prefer and delivers them few compensating economic benefits.

Both governance problems might be addressed by informing and mobilizing community members to assume a larger role in forest management. Seminal work by Ostrom argues that common pool problems abate when informed constituents participate in making and enforcing rules around resource use (7). Research on "social accountability" finds that initiatives that inform and empower citizens can increase the responsiveness of unelected governing bodies (8).

To address these governance problems and in coordination with experimental studies in five other countries (9), this paper evaluates a citizen monitoring (CM) effort in Bong County, Liberia. In our study area (Fig. 1), average deforestation rates are roughly 2% over the 2 years preceding the program (2016 to 2017), which is double the rate across Africa (2). Given the limited capacity of the Liberian state, forest-edge communities must establish and enforce rules governing the use or conservation of their community forest.* Yet, in our control communities, households appear disengaged, reporting little role in the design and enforcement of these rules. Households also possess inaccurate information about the current use of their community forest. For our intervention, a local nongovernmental organization (NGO) recruited, trained, and deployed monitors in 60 communities to regularly patrol communal forestland and convene public meetings to report their findings.

Using an experimental design across 120 communities and data collected through surveys, on-the-ground environmental assessments, and satellite-based forest observation, we find that CM generates more informed and inclusive governance of community forests (10). Over 70% of survey respondents in program

Significance

Global forest conservation depends on decisions made in the rural, often poor communities that live next to the Earth's remaining forests. These decisions often result in rapid deforestation. Coordinated with randomized experiments in five other countries, we evaluate a program that recruits and deploys citizens to monitor communal forestland in Liberia. By informing and mobilizing citizens, the program aims to address two potential governance problems: overuse due to common pool dilemmas and unaccountable leaders profiting from unwanted agribusiness or logging operations. We show that citizen monitoring corrects misconceptions about forest use, broadens participation in rule-making, increases accountability for chiefs (local leaders), and increases material benefits for households. We do not observe a decline in forest use.

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*We define a community forest as forestland owned by the community (not by a particular individual) that does not overlap with neighboring communities' claims and can be accessed and used by community members for various purposes, including private economic activities.

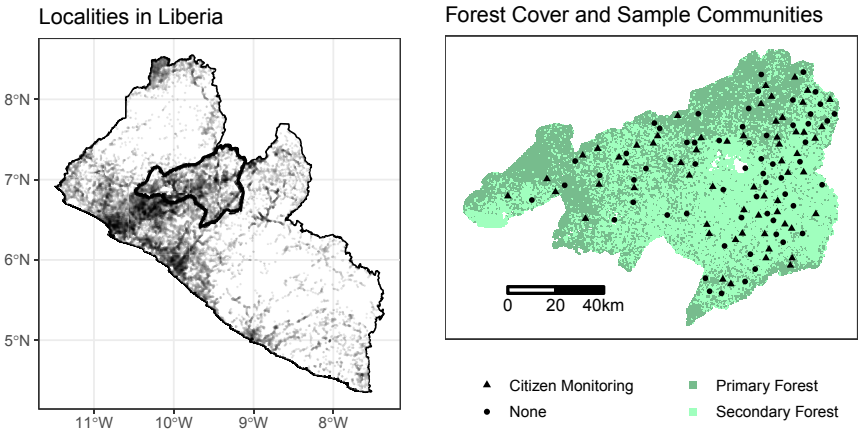

Fig. 1. Study area and treatment assignment.

communities report attending a community meeting about forest monitoring and learning new information at that meeting. Households in program communities hold better information about forest use, participate more in forest management and can better influence rules, and express more willingness to enforce these rules. Chiefs report heightened scrutiny of their forest management, attesting to strengthened accountability. These changes in governance generate material benefits for community members, who report receiving more of the benefits from logging or other external operations in their community forests.

CM does not, however, reduce forest use or remotely sensed deforestation. Our data suggest two explanations: first, common pool problems do not drive the depletion of communal forests in our study area; and second, both chiefs and their constituents prefer continued exploitation. Including households in forest governance does not empower a constituency that favors more radical conservation. To reduce forest loss, people need to be compensated for the costs of foregoing forest use that contributes to their livelihoods (11–13).

Our study responds to calls for experimental evaluations of strategies to manage global forests (14) and, in particular, of community-based or decentralized strategies (15, 16). We also contribute to a broader research agenda on social accountability, focusing here on a "mutual monitoring" mechanism for community management of natural resources (17).

Intervention and Research Design

Our descriptive analysis in *Governance of Community Forests in Liberia* suggests that, in rural Liberia, community members are uninformed about forest use and see no role for themselves in managing this communal resource. These baseline conditions motivate a CM intervention implemented by the local NGO, Parley Liberia.[†] The intervention was a form of mutual monitoring in which community leaders nominated community members to perform a regular monitoring task (17). In this section, we describe the essential features of the intervention and research design. We provide additional detail in our preanalysis plan and deviations from that plan in *SI Appendix*, section 7 (10). Slough et al. describe how this study was harmonized with concurrent randomized experiments in other countries (9).[‡]

The year-long intervention (mid-2017 to late 2018) was designed to facilitate more informed and inclusive decision-making about community forests. The chief in each program community was asked to nominate four monitors. Parley suggested that monitors be literate and numerate and include at least one woman (*SI Appendix*, section 2C).[§] Monitors received a full-day training, which explained the purpose and cadence of monitoring, allowed trainees to practice recording forest activities using both paper forms and a mobile device, and used role plays to coach trainees on how to arrange a community meeting to present their findings to chiefs and other community members. Monitors were instructed to present information about the types of forest use they uncovered and the scale of the activity. Parley then accompanied each team on three patrols, spaced at least 3 months apart. Parley also confirmed that monitors presented their findings at community meetings after each patrol.[¶]

Randomization. We randomly assigned communities to receive the CM intervention ($N = 60$) or to a control condition ($N = 60$).[#] We employed a blocked and restricted randomization, which ensures that candidate randomizations achieve a threshold level of balance for baseline covariates (*SI Appendix*, Table S13 shows balance) (18). We minimize geographic spillovers by constructing the sample to maximize the minimum distance between any two communities: the average distance between communities is 48 km; the minimum distance between any two communities averages over 4 km. We find no evidence of spatial spillovers in programming: respondents in control communities near monitoring communities are not more likely to report monitoring activities or an increase in meetings around forest management (*SI Appendix*, Table S23).

[†]The annual intervention cost was roughly $1,200 US dollars per program community. We believe this represents an upper-bound on the marginal cost of scaling the intervention, because we spaced out the communities to limit spillovers that could compromise our research design.

[‡]Relative to other cases in the metaanalysis, we see smaller effects on resource use in Liberia: as we illustrate below, community members do not face common pool problems and support the continued exploitation of forests for economic reasons.

[§]Over 70% of monitoring teams included three to five individuals; 69% of monitors have attended some secondary school (double the rate of households); 16% are female; and their average age is 38 years (*SI Appendix*, Table S1). We group monitors with other community leaders, as 64% of monitors come from households with a current or past community leader.

[¶]Per *SI Appendix*, section 2C, the forest monitors received a small incentive to complete their patrols and convene meetings; no other community members received compensation from the intervention.

[#]The citizen-monitoring intervention was cross-randomized with a second intervention using a 2 × 2 factorial design (see consort diagram in *SI Appendix*, Fig. S6).

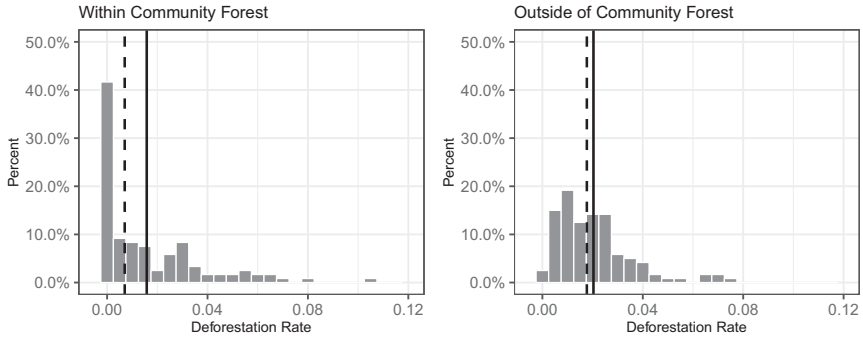

Fig. 2. Pretreatment forest loss in study communities (2015 to 2016). Distribution across study communities of 2-year, preintervention deforestation rates inside and outside community forests. The solid vertical line is the mean, and the dashed is the median. Estimates are based on 20 m × 20 m-resolution forest-loss data produced using Sentinel-1 and RapidEye imagery.

We estimate effects of the intervention using design-consistent regression estimators that account for the block randomization and any within-community dependencies in our data (Eq. **1**). Our design does not allow us to separately estimate the effects of the forest patrols and the community meetings that monitors convened to disseminate their findings.

Sampling and Data Collection. We followed the same data collection protocols in all communities. One set of enumerators administered surveys to each community's chief; five other community leaders who hold important roles within the community and are, thus, more likely to be involved in decision-making (e.g., the women's and youth leaders, the teacher); four randomly selected households; and, in program communities, up to five forest monitors. *SI Appendix*, Table S1 summarizes the demographics for these different sets of respondents. Respondents in program communities do not self-report greater conservation of the community forest or more frequently state that the community forest is "priceless," alleviating concerns that subjects in program communities feel pressure to express proconservation views (*SI Appendix*, Tables S17–S19).

Another team of enumerators conducted independent environmental assessments, which involved a 3-hour patrol of the community forest to record forest-use activities (*SI Appendix*, section 3). Finally, we measure deforestation with satellite data at a resolution of 20 m × 20 m; imagery comes from the Sentinel-1 and RapidEye satellites, and processing was done by Pix Force Tecnologia LTDA (*SI Appendix*, section 4). We define the variables constructed from these data sources in *SI Appendix*, Table S24.

Governance of Community Forests in Liberia

Globally, 1.5 billion people live in communities with collective forestland; in Liberia, forest communities assert rights over 45% the country's land area (19). Communities can use their forestland for private use, such as hunting, firewood and charcoal, or clearing for small farms. They can also negotiate use agreements with external actors, such as agribusiness, mining, or logging outfits. Small-scale logging crews (known as pitsawers) are the most prevalent external actors, and they typically pay royalties to fell trees in the form of cash, building materials, or other local public goods.

In the 2 years prior to our intervention, private and external forest use generated substantial rates of deforestation in Bong County (our study area). Fig. 2 uses satellite-based measures of deforestation in the 2 years prior to our interventions: we detect deforestation in about 60% of community forests; the mean both within and immediately outside of the community forest is roughly 2% over 2 y, which is double the average rate of net forest loss across Africa.[‖]

Our conceptual framework highlights two channels that could (separately or jointly) account for communities' forest use (*SI Appendix*, section 1). First, common pool problems could result in households each deciding to overuse the forest due to a failure to internalize the harms this imposes on their neighbors (3). Second, lax implementation of national laws devolves control to unelected local chiefs, whose policies and negotiations with external actors affect the conservation of their communities' forests (20, 21).[**] Chiefs' decisions affect both the intensity of forest use as well as how the benefits from any external forest use are shared between members of the community.

Contrary to some expectations set out in our preanalysis plan, common pool problems between households are not a primary concern in our study area. We find limited private use of community forests and no indication of conflicts between households about the exploitation of this communal resource. Only about one-fourth of households in our control group report conducting any private economic activities in their community forest in the 3 months prior to our end-line survey (*SI Appendix*, sections 5A and 5B). Only 4% of households and 5% of chiefs witness any conflicts between households related to the community forest in the year leading up to the survey. This is not to say that households are completely content: 27% express being upset about the use of their community forests (*SI Appendix*, Table S3). However, our data indicate that this anger is not a consequence of common pool problems among households. For these reasons, and—given space limitations, in *Results* below—we do not place emphasis on common pool problems between households.

The most salient problems in community forest management in our setting relate instead to accountability between households and chiefs. In our control communities, households either cannot or do not see it as their role to scrutinize chiefs' decisions related to communal forestland. Households agree that chiefs set down rules about use of the community forest, such as requiring prior approval to clear forestland for a new farm (*SI Appendix*, section 5D). However, they also agree they have little say in the design and enforcement of these rules. Only

[‖] In 2015, the average rate of annual net natural forest loss was 0.024% globally and in Africa was 0.54%, which would translate into roughly 1.1% cumulative loss in 2 y (2). Limited deforestation in the 2 years prior to our intervention does not imply that there is no scope to detect reductions; in fact, these communities may be the areas most likely to experience forest loss as investment activity expands.

[**] Central government policy initiatives, including both the 2009 Community Rights Law and the 2012 Chainsaw Milling Regulation, envision more inclusive and sustainable use of community forestland (19), but neither is regularly enforced.

5% of control households report participating in forest management (e.g., serving on a village committee); less than one in five households have recently spoken with their neighbors about the community forest (*SI Appendix*, Table S5). Community members' disengagement is further reflected in a lack of knowledge about external forest use. When we ask chiefs about past investment deals (both timber sales and leases for commercial agriculture), their responses predict our satellite-based measures of forest loss (*SI Appendix*, section 5F). Households' responses, by contrast, have no predictive power and tend to overstate the extent of investment activity (*SI Appendix*, section 5G). These patterns reveal participation and knowledge gaps that limit households' capacities to hold chiefs accountable when they make decisions about the amount of activity to permit in the community forest or how to distribute the benefits from any such activity.

How does the elite capture of forest governance affect conservation and benefit sharing? On the one hand, households value conservation: 95% in control communities feel it is important to protect the forest, water, and air, even if it means less income and fewer jobs (*SI Appendix*, Table S11).[††] On the other hand, substantial proportions favor greater forest use: roughly 30% would like to see more pitsawing (i.e., small-scale logging operations), private farms, and commercial concessions in the community forest—the major drivers of deforestation in our study area (*SI Appendix*, section 5I). Given these nuanced views, broader representation in forest governance is unlikely to generate either popular pressure to quickly sell off the community's forestland or a moratorium on forest use. There is less ambiguity around benefit sharing: most households prefer that benefits from external forest use be directly distributed to them rather than being dispensed to the chief. Households' exclusion enables chiefs to pocket more of these benefits.[‡‡] Reports provide examples of unaccountable chiefs exploiting households' disengagement to cut deals that enrich chiefs and threaten households' interests (23, 24).

Results

Our conceptual framework implies that CM, by encouraging more informed and inclusive governance of forests, increases chiefs' accountability to their constituents (*SI Appendix*, Fig. S1). We expect accountability to increase the congruence between constituents' preferences and chiefs' decisions related to conservation and the distribution of benefits from forest use. We focus here on results related to a causal chain running from monitoring, to engagement, information, and inclusion, to accountability, and finally to changes in conservation and benefit sharing.

Implementation. We first verify the implementation of the CM program and compliance with our randomized assignment. The first two rows of Table 1 use administrative data from our implementing partner: communities assigned to receive the program conducted 2.8 forest patrols and 2.5 community meetings over the year on average.[§§] Households report in the end-line survey that they know about the program and that it generated new opportunities to meet and learn about forest activity: 89% of respondents in monitoring communities report that the forest monitors are present and active, and over 75% attend a community meeting that discusses forest monitoring, compared with around 10% in communities without the program. While monitoring and meetings are not otherwise unheard of, the program dramatically increased their frequency and salience, remedying the disengagement we observe in control communities absent the intervention.

Table 1. Implementation of the CM program

Measure	No CM ($N = 60$)	CM ($N = 60$)
Community meetings	0	2.5
Community forest patrols	0	2.8
Monitors present and active	9.6%	89%
Attended monitoring meeting	10.8%	76.5%
Learned new information	10.3%	72.1%

Mean levels in control (No CM) and program (CM) communities for implementation indicators. See *SI Appendix*, Table S16 for all additional prespecified manipulation checks estimated using Eq. **1**.

Information, Inclusion, and Accountability. Over 70% of respondents in program communities learn new information at the meetings convened by forest monitors (Table 1). Constructing a family (i.e., mean-effects index) comprising prespecified measures of respondents' knowledge, we find that the intervention improves households' information about their community forest in Table 2 (Family 2). We see no improvements among community leaders or chiefs, who possess superior baseline knowledge (*SI Appendix*, section 5F).

This result reflects two important changes. First, households' estimates of forest use improve in accuracy; specifically, we find that their assessments of private forest use activities better track our independent environmental assessment (*SI Appendix*, Table S17). Second, the intervention closes the informational gap between households and their chiefs. We find that households' estimates regarding the size and use of their community forest better align with their leader's responses—what we term "informational congruence." While we estimate positive treatment effects on households for all measures in this information family, these coefficients are not all statistically significant, and the impacts on households' information about external forest use are small in magnitude.

Table 2 (Family 4) shows greater inclusion of households and community leaders in forest governance in program communities. Both households and community leaders report participating more in forest management (*SI Appendix*, Tables S17 and S18). The effect is larger for community leaders, although as we show in *SI Appendix*, Table S21 this estimate is driven by the citizen monitors themselves, who are included among the community leaders. Other community leaders and the chief tend to already be engaged, limiting the potential for the program to have an effect.

Households also resolve to help enforce rules around the community forest (e.g., prohibitions on cutting timber or clearing land without prior permission).[¶¶] We also find broader engagement by households and community leaders in rule-making and enforcement as a result of CM.

[††] We elicited how much households would have to receive to clear-cut their community forest, as well as the amount they would accept to indefinitely designate it as a protected area (barring any activity that causes forest loss). Households demand higher prices for clearing than conserving, reflecting the intrinsic value of conservation (*SI Appendix*, section 5H).

[‡‡] Village chiefs do not compete in regular elections, but they do risk removal if they contravene the interests of relevant constituents (22). The question is whether households can be excluded from this "relevant constituency."

[§§] Two communities severely restrict outsiders' access to their forestland and, thus, opted out of the patrols and community meetings. We do not rescale our intent-to-treat estimates to account for this minimal, one-sided noncompliance.

[¶¶] Attending quarterly meetings entails a small cost; these are scheduled to avoid interfering with economic activity. We did not measure the costs that households incur by volunteering to enforce rules. Their willingness to do so reveals that the perceived returns to this activity exceed the opportunity cost of their time.

Table 2. Effects of CM on survey-based outcomes

Family		Households (n = 477)	Community leaders (n = 757)	Chiefs (n = 123)
(1)	Manipulation checks	2.37 (0.15)***	3.12 (0.11)***	3.23 (0.21)***
(2)	Information about community forest	0.39 (0.19)**	−0.20 (0.18)	0.08 (0.16)
(3)	Preferences over conservation	0.17 (0.10)*	0.19 (0.09)**	0.21 (0.18)
(4)	Inclusion in forest governance	0.22 (0.08)***	0.20 (0.08)**	0.06 (0.19)
(5)	Accountability of chief	0.24 (0.10)**	0.17 (0.09)*	0.41 (0.23)*
(6)	Sanctioning capacity of chief	0.02 (0.08)	−0.04 (0.06)	−0.00 (0.27)
(7)	Benefit sharing	0.30 (0.15)*	0.26 (0.15)*	−0.10 (0.29)
(8)	Conservation	−0.08 (0.08)	−0.00 (0.12)	−0.10 (0.13)
(9)	Displacement	0.09 (0.10)	−0.09 (0.12)	0.07 (0.17)

The table presents estimated treatment effects (with SEs) on mean effects indices for each of the thematic families listed to the left. Each mean effect index aggregates a set of prespecified outcome indicators. Effects are expressed in control-group standard deviations. The "Conservation" family presented here only includes survey-based measures. SEs are clustered on community, which is the unit of assignment. *SI Appendix*, Tables S17–S19 report results for the individual indicators that constitute each family. *$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

Both households and community leaders also report greater influence over the rules that govern their communities' forests. These effects are substantial, greater than 0.25 SDs and statistically significant for both groups (*SI Appendix*, Tables S17 and S18). Furthermore, chiefs take note of this increase in informed participation, reporting that they feel more scrutiny around how they manage their communities' forest—an expression of heightened accountability (*SI Appendix*, Table S19). This increase in informed participation does not create strife in monitoring communities; accountability may prevent or speed the resolution of grievances. Households and chiefs both report reductions in conflicts ("palavas" or "bad feelings") about forest use, although neither coefficient is statistically significant. When we aggregate these measures, we find improvements in accountability in Table 2 (Family 5) for all groups.

Conservation and Benefit Sharing. Ex ante, it is not obvious that more inclusive and accountable local governance will reduce the use of community forests. While global actors focused on climate change may want to preserve forest cover, households prefer a mix of continued private use and (increased) external investment; depleting global carbon stores is an externality.

In Table 3, we estimate a small and statistically insignificant decline in deforestation (roughly 7% relative to communities without the monitoring program) using our remotely sensed (satellite) measure of forest loss. (*SI Appendix*, Table S25 reports an alternative, prespecified analysis that generates qualitatively similar results.) Recognizing that remotely sensed forest loss may not capture smaller or more recent changes in behavior, we also look for changes in detected use: our independent environmental assessments uncover no significant changes in private or external forest use. No group of survey respondents reports a significant change in forest use. Even forest monitors do not report significant declines relative to other community leaders (*SI Appendix*, Table S20). Given that use of the community forest remains unchanged, it is unsurprizing that we find no evidence in Table 2 (Family 9) that activity was displaced to forested areas outside the community forest (see also *SI Appendix*, section 6F).

More inclusive governance does not limit use. We do, however, find in Table 2 (Family 7) that households and community leaders in monitoring communities report more benefits from external investments in their community forests. Looking closer at what types of benefits accrue to these respondents, households are more likely to report receiving payments (money or other tokens) related to external investments in program communities. Community leaders report receiving more building materials (e.g., planks). By contrast, we see a negative overall effect among chiefs and a reduction in the proportion reporting payments from external investment (*SI Appendix*, Table S15), although neither effect for chiefs is statistically significant. Sharing more benefits with households does not appear to deter forest use by external actors: the 95% CI around our estimate in Table 3 excludes a substantial reduction. This indicates that the chief is either redistributing benefits he would have otherwise pocketed or that the chief successfully drew larger royalties from external actors. It also implies that external actors were not deterred by such changes.

One alternative (although not mutually exclusive) explanation for increased benefit sharing is that households demand more from their chiefs. Monitoring may not only increase accountability, it could change the demands that households make of their chiefs. We elicit the lump-sum payment households would have to receive to permit the clear-cutting of their community forest. We find in exploratory analysis that monitoring increases households' and community leaders' demands (*SI Appendix*, Table S14). Moreover, while none of the coefficients for the constituent measures is statistically significant and we see no changes in self-reported use, we find significant changes at the family level in households' and community leaders' preferences over conservation in Table 2 (Family 3). It could, thus, be the case that chiefs face both heightened accountability and demands in program communities.

Conclusion and Policy Implications

We find that a program to recruit, train, and deploy citizen monitors to regularly patrol communal forests in Liberia leads to more informed and inclusive resource governance. In our control communities, households appear disengaged. In program communities, they assume a greater role in crafting and enforcing rules around forest use and are able to garner more material benefits from logging and other external operations in their communities' forests.

Democratizing forest governance and more broadly distributing the material benefits from external investments are both

Table 3. Effects of CM on independently assessed forest loss

Measure	ATE (SE)	N
Forest loss (satellite)	−4.61 (19.15)	120
Private forest use (env. ass.)	0.06 (0.55)	118
External forest use (env. ass.)	0.46 (0.28)	118

Forest loss is a count of deforested pixel from satellite measures; other effects are from independent environmental assessments and are expressed in control-group SDs. SEs are clustered on community. Two communities (of 120) do not permit outsiders in their community forest and refused the environmental assessment (env. ass.).

worthy goals. Yet, we do not find that CM reduces deforestation, which is the primary objective for policymakers focused on mitigating climate change. Promoting conservation likely requires compensating community members for the costs of foregoing forest use. Payment for ecosystem services (PES) programs (e.g., Reducing Emissions from Deforestation and Forest Degradation Plus, or REDD+) adopt this approach and have shown success at promoting biodiversity and curbing forest loss (12, 13). However, elite capture can undermine such schemes: PES may do little to curb forest loss where it lacks popular support and does not distribute benefits to a broad base of potential users (25, 26).[##] CM could constitute an important complement to these programs by ensuring that conservation agreements reflect households' interests and contribute to their economic well-being. If governance problems remain unaddressed, conservation schemes risk both failure and further entrenching inequality in forest-edge communities.

Materials and Methods

Estimation. Given random assignment of the CM treatment, we improve precision in estimating the average treatment effect (ATE) by fitting the following centered-interaction specification (28):

$$Y_{ibc} = \alpha + \beta \mathrm{I(CM)}_{bc} + \phi_1 \tilde{\mathrm{I}}\mathrm{(NEG)}_{bc} + \phi_2 \mathrm{I(CM)}_{bc} \times \tilde{\mathrm{I}}\mathrm{(NEG)}_{bc} + \sum_{b=1}^{B-1} [\phi_{3b} \tilde{\mathrm{I}}_b + \phi_{4b} \mathrm{I(CM)}_{bc} \times \tilde{\mathrm{I}}_b] + \varepsilon_{ibc}, \quad [1]$$

where Y_{ibc} corresponds to the outcome for individual i in district randomization block b and community c, and $\mathrm{I(CM)}_{bc}$ is an indicator variable for whether community c in block b hosted the CM treatment. We control for whether the community also received a second randomized treatment arm (subject to a separate analysis), which was a negotiation training ($\mathrm{I(NEG)}_{bc}$). The $\tilde{\cdot}$ operator means that the variable is centered. We include district block fixed effects (I_b). For community-level data, we simply drop the i subscript.

The term β is our ATE estimate for CM. (Because the $\tilde{\mathrm{I}}\mathrm{(NEG)}_{bc}$ term is centered, β estimates the marginal ATE of monitoring, averaging over communities both with and without the negotiation training.) The various ϕ terms are nuisance coefficients for the control variables.

Forest loss is a relatively rare event. To improve efficiency, our analysis of deforestation controls for the number of preintervention pixels that are primary or secondary forest, as well as forest loss in the 2 years prior to the launch of the intervention. We did not conduct a baseline survey, so we cannot condition on baseline outcomes when analyzing our survey or environmental assessment data. We cluster our SEs on community, which is the unit of assignment.

Measurement. Remotely sensed forest loss is measured as a count of deforested pixels. Outcomes from the survey and environmental assessment are control group-standardized measures. To standardize, we use statistics from the control communities for which both I(CM) and I(NEG) are 0. We do not separately standardize by respondent type. *SI Appendix*, Table S24 defines the variables we use for analysis.

Ethical Approval. This study was approved by the Institutional Review Boards at the University of California, Los Angeles (18-001684); University College London (10205/003); and New York University (FY2017-912). All subjects gave consent to participate in our study.

Data Availability. Preanalysis plan and replication data are available on the Open Science Framework (https://osf.io/arju7). Data from this study are also used in a metaanalysis; the preanalysis plan and replication data for that metaanalysis are also available on the Open Science Framework at https://osf.io/5pvud.

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[##]These programs must also take care not to crowd out intrinsic motivations for conservation (27), which are apparent in our survey data (*SI Appendix*, Table S11).

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