Voluntary leadership and the emergence of institutions for self-governance

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Strong local institutions are important for the successful governance of common-pool resources (CPRs), but why do such institutions emerge in the first place and why do they sometimes not emerge at all? We argue that voluntary local leaders play an important role in the initiation of self-governance institutions because such leaders can directly affect local users' perceived costs and benefits associated with self-rule. Drawing on recent work on leadership in organizational behavior, we propose that voluntary leaders can facilitate a cooperative process of local rule creation by exhibiting unselfish behavior and leading by example. We posit that such forms of leadership are particularly important when resource users are weakly motivated to act collectively, such as when confronted with "creeping" environmental problems. We test these ideas by using observations from a laboratory-in-the-field experiment with 128 users of forest commons in Bolivia and Uganda. We find that participants' agreement to create new rules was significantly stronger in group rounds where voluntary, unselfish leaders were present. We show that unselfish leadership actions make the biggest difference for rule creation under high levels of uncertainty, such as when the resource is in subtle decline and intragroup communication sparse.

leadership | governance | sustainability | common-pool resources

Most scholars and practitioners agree that strong local institutions represent a key ingredient for successful local governance of shared natural resources, such as forests, groundwater basins, and fisheries (1–3). There is less consensus about the origins of such institutions. Why do local users voluntarily assume the substantial costs of self-organizing to create rules that ultimately limit their individual freedoms? Here, we analyze the emergence of local systems of self-governance, paying particular attention to the role of local leadership.

The role of local leadership in environmental governance remains underexplored both theoretically and empirically. Given the prominence of leadership as a feature of most human organizations, it is puzzling that leadership has not received more attention in the modern literature on environmental governance. Many of the seminal contributions to the literature on local environmental governance are surprisingly silent on the role played by leadership in fostering effective local institutions (e.g., refs. 4–6; but see ref. 7). For example, Ostrom's eight design principles for robust institutional arrangements to govern common-pool resources (CPRs) focus on the attributes of biophysical resources and user groups and do not include leadership (5).

Outside the environmental governance literature, however, leadership is a much more developed area of scholarship. For example, findings from studies in organizational behavior and business management make a compelling case for why unprompted acts of local leaders might make a difference for strengthening the governance of shared resources (e.g., refs. 8–10). Here, we borrow from these literatures to develop and test a series of propositions about the role of voluntary leadership in the emergence of institutions for environmental self-governance.

The main contribution of this paper is that it presents evidence on the role of voluntary local leadership in the creation of new institutional arrangements for governing shared natural resources. We show that unselfish leadership makes the biggest difference for mobilizing agreements on self-rule when uncertainties about social and environmental dynamics are high.

Our empirical data come from a framed laboratory-in-the-field experiment with 128 forest users in eight villages in Bolivia and Uganda. These participants made individual extraction decisions from a shared resource with dynamic biophysical properties. Our experiment generated longitudinal observations of forest users' interactions and decisions in a controlled field environment, allowing us to model the dynamic process of how voluntary leaders can promote the emergence of self-governance institutions during the initial stages of collective action, before more formalized structures and processes are in place.*

Leadership and the Creation of Local Institutions for Environmental Governance

An increasing number of scholars agree that leadership can be an important contributor to the effectiveness of existing governance institutions for CPRs. For example, previous research has shown that leaders can improve the performance of institutions to stabilize resource stocks (12, 13), promote the establishment of management organizations (14–16), and help reorienting organizational goals toward increased sustainability (17, 18).

If leadership can make existing institutions more effective, it seems reasonable to expect leadership to play an even greater

Significance

We offer evidence on the role of local, voluntary leaders during the initial stages of the self-governance process. Our findings, which show that unselfish leadership actions can foster self-governance under conditions that are unfavorable for collective action, provide hope for efforts to address creeping environmental degradation problems, such as climate change and biodiversity loss. The significance of these findings goes beyond environmental policy and speaks to the potential role of voluntary leaders in the formulation of policy responses to new, emerging threats to human well-being for which there are no established governance institutions.

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*Because there are many contextual factors and conditions that influence the creation and performance of local institutions, it is always a challenge to conduct controlled comparative analyses, but behavioral experiments can help address such analytical challenges (11).

role during the initial stages of the self-governance process, before institutions begin to structure human interactions and guide the decisions of resource users. There is a dearth of scholarship, however, when it comes to analyzing the roles of leadership during the initial stages of the governance process (19). This is a significant shortcoming because the role of leadership is likely to be particularly influential during these initial stages of the governance process (20–22).

Scholars who study collective-action problems refer to the challenge of creating institutions to address social dilemmas as a second-order public-goods problem. While several previous studies have analyzed the role of leadership in addressing second-order public-goods problems—for example how a leader can facilitate group consensus on how to monitor and enforce rules—much of this work focuses on the influence of formally selected, individual leaders on the effectiveness of existing institutions within formal organizations in industrialized societies (e.g., refs. 22–24). Here, we build on these previous studies to develop and test a theory of how voluntary leadership actions, sometimes performed by multiple group members, affect the emergence of new governance institutions among the users of a CPR.

We define voluntary leadership as the actions of individuals who voluntarily take the initiative to speak up and propose a course of action for the group (25). Our study focuses on the unprompted acts of voluntary leadership, not the actions of formally appointed leaders. The reason for this choice is simple: We are interested in the creation of institutions during the initial and highly unstructured stages of collective action, before the group has decided on its objectives, bylaws, or formally elected leaders. Leaders who have been appointed through a formalized institutional process—either through elections or other political selection procedures—are different from these voluntary leaders in that formal leaders are themselves products of institutions. Formal leaders also have the ability to draw on politically derived authority. Unprompted, voluntary leaders, on the other hand, do not require any preexisting formal institutions and are not endowed with political authority to operate. In fact, the type of leadership that we study here is such that any group member is free to shoulder the role of a voluntary leader. We suggest that this type of unprompted, voluntary leadership can help mobilize local resource users' support of local institutions to govern CPRs.

Hypotheses

We explore the role of voluntary leadership in the initiation of a self-governance process and propose that unprompted, voluntary leaders play an important role in triggering collective action, especially during the initial stages of institutional development. In developing our argument, we rely on Elinor Ostrom's theory of self-governance (5, 26), which proposes that resource users will invest in the creation of new institutional arrangements for self-governance when their perceived benefits from self-governance outweigh the costs.

As resource users consider creating governance institutions, they confront significant transaction costs—the costs associated with the identification of plausible solutions, negotiation of rules that users believe are fair, and the monitoring of users' compliance (27, 28). These transaction costs often represent significant barriers to collective action, especially when resource users face high levels of uncertainty (29). In CPR dilemmas, users confront uncertainties related to both the biophysical and social contexts. Uncertainties about the biophysical context include how resilient the resource is to harvesting and whether the current level of extraction is sustainable (30). Within the social context, users face uncertainties concerning the likely behavior of other group members and their contributions to the institution-building effort (31, 32). We argue that voluntary leadership can help reduce some of these transaction costs and, much like the actions of political entrepreneurs, provide an initial boost to self-governance (33, 34).

There are several things that voluntary leaders can do to reduce the transaction costs associated with the creation of common rules. They can facilitate a shared understanding of the social dilemma and possible response strategies (27). They can help reduce the time and effort needed to identify rules that participants perceive as fair and effective (35). They can also reduce the uncertainties about the behavior of others in the social dilemma by divulging information about their own decisions and behavior, as well as asking group members for their commitments to cooperate (24, 31). Even if leaders do all these things, however, it may not be sufficient for reaching strong participant agreements on new rules because participants may question the leader's legitimacy (whether the leader sincerely has the best interest of the group at heart or has other more selfish motives). One of the things that voluntary leaders can do to establish their legitimacy is to take unselfish actions in the social dilemma. When participants conclude that their leaders voluntarily constrain their personal freedoms and interests for the benefit of the group, it will strengthen the participants' trust in their leaders and increase their willingness to follow suit, leading to increased confidence in the group's ability to generate positive net-benefits through cooperative institution building. Following this logic, we propose three testable hypotheses.

Hypothesis 1: Unselfish Leadership Activates Norms of Reciprocity, Increases Intragroup Trust, and Produces Higher Degrees of Agreement on New Rules. Empirical studies in organizational behavior and management show that leaders are more effective in promoting cooperation when their own cooperative behavior sets an example for other group members (9, 10, 36). Such unselfish behavior may be motivated by the leaders' expectations for social recognition, reputation gains, or simply a sincere concern for their fellow community members' well-being (37). Unselfish leadership actions foster cooperative institution building by activating norms of reciprocal fairness that prompt participants to follow their leaders' prosocial behavior (9, 38, 39). When a significant proportion of the group members reciprocate the leaders' cooperative behavior, it reduces the uncertainties about other group members' commitment to cooperation, increases levels of intragroup trust, and results in stronger agreement on common rules.

Hypothesis 2: Unselfish Leadership Affects Rule Creation the Most When Resource Users Perceive a Weakly Threatened Resource. CPR theory proposes that resource users are more likely to contribute to the creation of self-governance institutions when they perceive that their resource is threatened: for example, when they experience sudden and severe resource scarcity (26, 40). In other words, a perceived resource crisis pushes users to cooperate, increasing their perceived benefits of such cooperation, hoping that it is not too late to evade a very costly resource collapse. Rapid declines in the stock of CPRs send a clear and unambiguous signal to resource users: Unless you take imminent cooperative action, you may lose the resource altogether.[†] On the other hand, when there is a more subtle decline in the resource—when users experience a slow, gradual degradation of the CPR stock—the feedback signal from the resource is more ambiguous, producing more uncertainty about what ought to be the response from the users. Such conditions of uncertainty provide more room for opportunistic, self-interested behavior (41). We propose that it is under these conditions of relatively high uncertainty that we will see the strongest effect of unselfish

[†]Studies in organizational behavior identify a psychological mechanism that helps explain the observed positive effect of a resource crisis on cooperation: In times of crises, people tend to react emotionally, seeking refuge from the crisis among their peers, hence becoming more motivated to set aside their short-term material interests in favor of cooperative solutions to the crisis (58, 59).

leadership on agreements to create common rules. Unselfish leadership makes the biggest difference for mobilizing support for self-governance when resource users face creeping environmental problems, not when there are clear and imminent threats to the resource.

Hypothesis 3: Unselfish Leadership Will Have the Strongest Influence on Members' Acceptance of New Rules When Intragroup Communication Is Relatively Sparse. Experimental evidence from the environmental governance literature shows that interpersonal communication is fundamental to enabling CPR users to reach cooperative solutions to social dilemmas, including the creation and enforcement of rules to avoid a tragedy of the commons (42–44). Face-to-face communication among users helps reduce uncertainties about the state of the resource, possible response strategies, and the likely behavior of other group members (45). Following the logic that unselfish leadership makes the biggest difference for cooperation when uncertainties are high, we propose that unselfish leadership will have the strongest influence on members' acceptance of new rules when interpersonal communication within the group is relatively sparse.

Empirical Approach

To test these ideas, we analyzed observations from a behavioral laboratory-in-the field experiment with 128 forest users from eight different villages in Bolivia and Uganda. The experiment, a modified version of the appropriation game (42), involved eight participants who made simultaneous, private decisions about appropriations from a common-pool forest. We allowed face-to-face communication among participants during the entire experiment. The variables used in the analysis come from recorded individual decisions during the 15 rounds of the experiment, and from independent observer data on participant behavior during the experiment (all variables are described in *SI Appendix*, Table S2). Multiple field assistants independently coded several participant behaviors, including the degree of participant agreement on introducing common rules to regulate the CPR, the existence and identities of voluntary leaders in the group, and the extent of intragroup communication (see observer protocol and codebook in *SI Appendix*, section 5). After making sure these independent observations met the intercoder reliability test (*Materials and Methods*), we averaged these independent observer scores to create our dependent variable, as well as several independent variables of interest.

Our main outcome variable, Rule Agreement, reflects the degree of participant agreement on creating rules in a given round. For ease of interpretation, we converted the averaged observer scores into a proportion of the maximum possible score for this variable, producing the temporal distribution for each of the 16 groups as shown in Fig. 1.

Unselfish Leadership is a binary variable based on two different data points in the experiment: 1) Independent observers identified at least one leader during the round—an individual who took the initiative to propose a course of action for the group, and 2) decision cards from the previous round showed that the individuals identified as leaders harvested at, or below, the Pareto optimal level. For group rounds that met both criteria, we coded Unselfish Leadership as 1, and all others as zero.

As in real-life CPR dilemmas, individual decisions in the experiment were private. To deal with the uncertainties about the behavior of leaders and others in the group, participants relied on several alternative sources of information, such as 1) oral communication, 2) nonverbal cues, 3) prior knowledge of participant personality types, and 4) feedback on group-level results from previous rounds. Participants combined information from all four sources to infer whether leaders behaved in ways that benefited the group as a whole (unselfish leadership), or mostly themselves individually (selfish leadership) (31). In *SI Appendix*, section 3, we show data to support these assumptions.

Data from the field experiment allow us to conduct a dynamic analysis of the role of voluntary leadership in the formation of self-governance institutions among forest users. To estimate the effect of changes in voluntary leadership actions within groups on the degree of participants' agreement on new rules, we employed a linear regression model with group fixed effects.

Results

Our results provide empirical support for our hypotheses, demonstrating that 1) unselfish leadership facilitates stronger group agreement on rules; 2) unselfish leadership transforms group

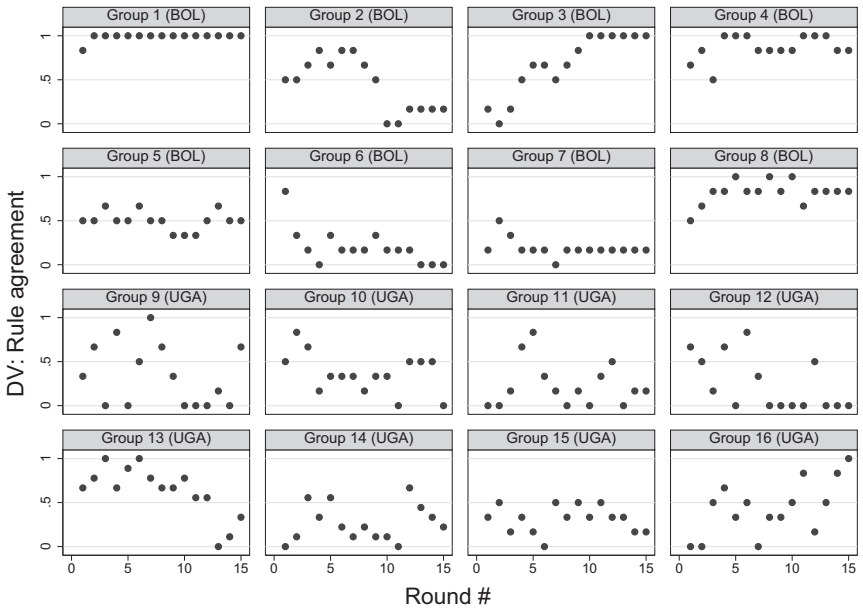


Fig. 1. Distribution of the dependent variable (Rule Agreement) over all 15 rounds of the experiment, displayed by group. Each of the plots corresponds to the over-time variation in rule agreement for a given group.

dynamics by increasing information sharing, reciprocal cooperation, and intragroup trust; and 3) unselfish leadership is more influential under greater levels of biophysical and social uncertainties.

Unselfish Leadership Facilitates Stronger Group Agreement on Common Rules. Our results support the idea that voluntary leaders who demonstrate unselfish behavior in their own decisions are effective in mobilizing participant agreement on rules. The presence of Unselfish Leadership is associated with an average increase of about 14 percentage points in participant agreement on new rules ($P < 0.05$) compared to group rounds without such leadership. Our analysis also considers the effect of Selfish Leadership (leaders whose harvesting decisions in earlier rounds are higher than what is optimal for the group), but this variable is not significantly associated with the degree of agreement on rules. Unselfish leadership actions appear to outperform more selfish leadership actions, at least when it comes to mobilizing broad group agreements on new rules to regulate CPRs. Using the results from model 1, a Wald test indicates that the effect of unselfish leadership on rule agreement is significantly stronger than that of selfish leadership ($P < 0.01$).

To make sure the observed positive effect of unselfish leadership is not due to the presence of confounding factors, such as the personal traits of the leaders (e.g., the leader is an elder, more educated, wealthier, or a female individual), model 3 includes four additional control variables that measure leader attributes linked to the effectiveness of leaders (7, 14, 15). Adding these controls only strengthened our main finding, increasing the substantive effect and statistical significance of the coefficient for Unselfish Leadership ($P < 0.01$). Model 3 results give us some confidence in the general magnitude of the relationship found in models 1 and 2. We conclude that it is unselfish leadership actions, not individual leader characteristics, which best explain variation in rule agreement.

Consistent with findings from the environmental governance literature, our results show that strong rule agreement is significantly associated with higher rates of resource decrease in previous rounds ($P < 0.01$) and ample communication between group members ($P < 0.10$) (26, 40). Substantively, for each additional row of 10 trees that decreased over the previous two rounds, there is a corresponding five percentage-point increase in the degree of rule agreement for the group round. One additional group member participating in the between-round discussion increases agreement on rule declaration by four percentage points. When all eight individuals participate in intragroup communication, the degree of rule agreement in the round increases by 32 percentage points (compared to group rounds with 0 to 1 speaker).

Unselfish Leadership Transforms Group Dynamics by Increasing Information Sharing, Reciprocal Cooperation, and Intragroup Trust. We theorized that unselfish leadership is instrumental in mobilizing resource user support for the creation of common rules because such leadership reduces the uncertainty about the likely behavior of other participants in the social dilemma. If true, we would expect group rounds with unselfish leaders to exhibit more cooperative participant behavior compared to group rounds without such leaders. Comparing several indicators of cooperative behavior in group rounds with and without unselfish leadership, we found evidence that is consistent with the proposed causal process. Participants in group rounds with unselfish leaders share personal harvesting decisions to a greater extent ($P < 0.01$), talk more about ways to coordinate decisions ($P < 0.01$), and are observed to exhibit greater interpersonal trust ($P < 0.01$) (*SI Appendix*, Table S7).

Unselfish Leadership Is More Influential under Biophysical and Social Uncertainties. We hypothesized that the effect of unselfish leaders on self-governance will depend on changes in the scarcity of the resource, as well as the intensity of the intragroup communication—factors that are known to directly influence the perceived uncertainties about the biophysical and social contexts of the CPR dilemma. We tested these ideas by interacting the variable for unselfish leadership with variables measuring "Resource Decrease (t-2)" and "Number of Speakers" (Table 1, models 2 and 3). Fig. 2 shows the marginal effect graphs for these interaction terms.

We find that the effect of unselfish leadership is the strongest when resource users experience great uncertainties about the condition of the resource (small decreases in resource availability), as well as about the likely behavior of other users (little or no interpersonal communication). Fig. 2*A* displays the effect of unselfish leadership for varying levels of forest stock decreases, and Fig. 2*B* for varying levels of interpersonal discussion. When there is greater certainty about the resource trend and participant behavior—with high decreases in resource availability or extensive interpersonal communication—the positive effect of unselfish leadership disappears. At very sparse intragroup discussion (one speaker or less) and when stock decrease is not drastic (below 30% decrease compared to original stock), the marginal effect of unselfish leadership is positive, substantively large, and statistically significant ($P < 0.05$): Under such extreme uncertainties, unselfish leadership is associated with a 53-percentage point increase in rule agreement.

Discussion

The uncertainties about the biophysical and social dynamics within shared resource systems complicate local efforts to address CPR dilemmas. These uncertainties are particularly substantial before governance institutions are put in place and begin to structure human interactions (5, 46). We show that unselfish, voluntary leadership actions can help reduce these uncertainties before institutions take effect. In fact, we find unselfish leadership to be most influential at initiating self-governance institutions when uncertainties are high: when there is a subtle decrease in resource availability and when communication is sparse. This result suggests that unselfish leadership can help overcome collective action problems when groups face conditions that are usually unfavorable for achieving cooperation.

These findings provide possible inroads to deal with a persistent paradox in environmental policy: Without an overwhelming sense of urgency, such as that conveyed by an imminent crisis or a sudden catastrophic event, policy makers often fail to prioritize environmental protection (47). By the time a "creeping" and slow-moving problem, such as climatic change or biodiversity loss, has gotten to the point of being perceived as a real crisis, political action may have fewer affordable options (48). Our findings suggest that unselfish leaders can help avert this paradox by motivating their followers to address creeping environmental problems before becoming a catastrophe. The substitution effect of unselfish leadership with known drivers of self-governance offers some hope for efforts to foster self-governance to protect the environment.

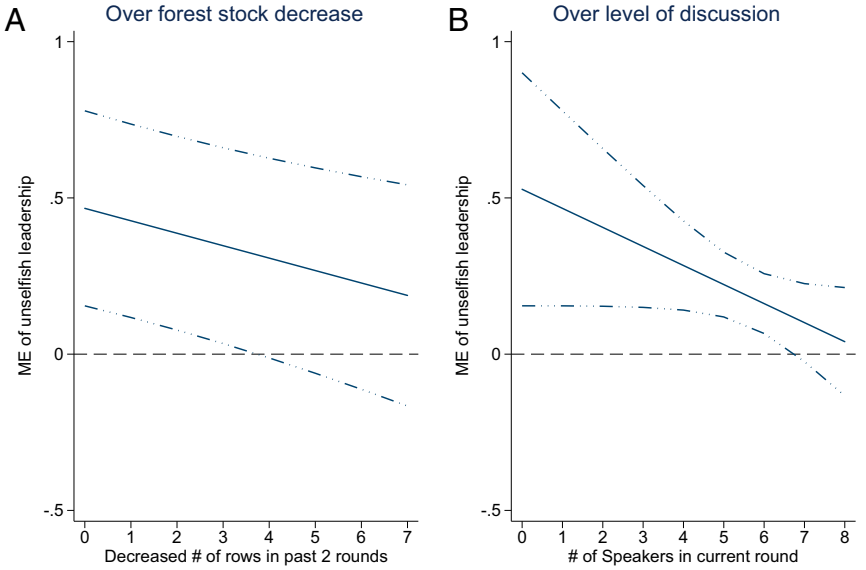
Our findings are most relevant to informal organizational contexts where existing local CPR governance institutions are weak or missing. The findings are less applicable to formal organizational contexts where governance institutions are often well-established (e.g., with hierarchical structures, chains of command, and formally assigned leadership roles with official mandates), but there may be specific situations within formal organizations for which our results are instructive. One such situation is when new issues or problems appear that the organizations do not have a formulated policy response to. When an organization's formal leadership does not respond in a timely manner, there may be room for informal, voluntary leadership within the organization to mobilize internal support for new institutional responses. For example, student leaders around the

Table 1. Results of group fixed-effects regression analysis

Variables	(1) Rule agreement (DV)	(2) Rule agreement (DV)	(3) Rule agreement (DV)
Leadership actions			
Unselfish leader (A)	0.14 (0.05)**	0.53 (0.19)**	0.57 (0.17)***
Selfish leader	0.06 (0.06)	0.03 (0.05)	0.09 (0.07)
Leader traits			
Older			−0.11 (0.08)
Male			−0.01 (0.08)
More educated			−0.10 (0.07)
Wealthier			0.05 (0.09)
Social environmental context			
Resource decrease (t-2) (B)	0.05 (0.01)***	0.05 (0.02)***	0.05 (0.02)***
No. of speakers (C)	0.04 (0.02)*	0.06 (0.02)**	0.05 (0.02)**
No. of leaders	0.01 (0.03)	0.01 (0.03)	0.06 (0.04)
Interaction terms			
A x B		−0.04 (0.02)**	−0.03 (0.02)*
A x C		−0.06 (0.03)*	−0.06 (0.03)*
Round	0.00 (0.01)	−0.00 (0.01)	−0.00 (0.01)
Constant	0.11 (0.12)	0.04 (0.13)	0.05 (0.13)
No. of cases	208	208	208
r^2	0.20	0.23	0.26
Aic	−80.56	−85.20	−83.94
Bic	−60.53	−58.50	−43.89
Rmse	0.20	0.19	0.19

Coefficient listed with SEs in parentheses. The results support the hypothesized positive effect of voluntary, unselfish leadership on participants' agreement on new rules (model 1). This positive effect is enhanced under high levels of uncertainty—when there are small decreases in resource availability and when interpersonal communication is sparse (model 2). Blank cells in column for model 1 and model 2 results indicate that these variables were omitted from the analyses. *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$. (1), model 1; (2), model 2; (3), model 3; Aic, Akaike information criterion; Bic, Bayesian information criterion; Rmse, root-mean-square error.

world are mobilizing fellow students and faculty to pressure their university leaders to adopt more progressive climate policies. Another example comes from the private sector where employees have organized climate strikes to protest against their company leaders' lack of action on climate change. Unselfish leadership actions likely shape the effectiveness of such campaigns, but this is a hypothesis that we leave for future studies in organizational behavior.



Note:(a) At no discussion (Speaker number = 1); (b) At no stock decrease

Fig. 2. Marginal effect of unselfish leadership, under different conditions of (*A*) stock decrease (during previous two rounds) and (*B*) the number of speakers.

Future work can also help overcome several methodological limitations in our study. First, future work can strengthen the signaling that leaders rely on in our experiment. Because the decisions of voluntary leaders were private and simultaneous to the decisions of other group members, participants cannot know exactly how many trees leaders harvested in a given round. Participants in the experiment need to infer—based on several alternative sources of information—what the likely actions of their leaders were. While real-word CPR dilemmas also require group members to rely on inferences about leadership actions (because these are rarely fully public), it would be desirable to collect specific participant data to be able to test the participants' ability to make accurate inferences about the behavior of others, as done in some previous work (49). Another improvement would be to document a variety of leadership actions during the experiment, such as what the leaders said to promote cooperation. Data on message content would allow for more in-depth analysis of the effect of specific leadership strategies beyond the degree of selfish behavior.

Finally, achieving high external validity is always a challenge for behavioral experiments. To address this challenge, we implemented our experiment in the field with actual forest users rather than with our undergraduate students (50). We also framed the decision tasks to resemble the CPR dilemmas that these forest users face on a regular basis (51), and we used monetary payoffs to introduce tangible consequences for decisions made during the experiment. Even so, it is still a simulation, which can never fully capture the complexity of forest users' decisions in real-world CPR dilemmas (52). Readers should interpret the results in light of these limitations.

These limitations notwithstanding, our methodological approach offers a potentially useful reference to scholars interested in testing context-dependent theories about human behavior in complex social–environmental systems. One of the challenges in testing such theories is to control for the large number of contextual factors that may affect outcomes (53). Our laboratory-in-the-field experiment provided a stable test bed where we could control for many of these contextual variables, without completely decimating the external validity of the results. Our study suggests that there is a productive middle ground between narrow experimental studies of environmental behavior in the laboratory (with weak external validity but strong causal identification) and comparative analyses of field observations of behavior in actual groups and organizations (with weak causal identification but strong external validity). We chose a design that traded some of the causal identification for stronger external validity, while also generating meaningful variation on voluntary leadership actions.

Our study underscores the usefulness of viewing leadership as an action, not an individual person or her personality traits. In our experiment, we observed substantial variation in leadership actions: Leadership actions came from multiple individuals and at multiple different points in time. We saw participants responding to unselfish leadership actions, more so than to individual traits of leaders. Such fluidity of leadership in groups is an aspect missed by many conventional designs of leadership experiments that rely on formal selection mechanisms to identify a single individual to be the group leader for subsequent rounds of the experiment.

The upside of shifting the focus of leadership from individual personas with certain personal characteristics (e.g., formal education, elder) to leadership actions (e.g., prosocial behavior) is that such research will likely produce more practical and actionable findings for organizations supporting local governance processes. Existing research on environmental governance provides little guidance as to how interventions can foster greater local motivation to contribute to local governance institutions because many of the known motivators of self-governance are structural (secure property rights, markets for managed resources, salient resource is threatened, etc.) and are beyond the control of most practitioner organizations (54). More research on the effectiveness of a greater variety of specific leadership actions and strategies, on the other hand, is potentially useful for such organizations because these usually have little choice but to work with the existing local leadership, whatever their personal characteristics might be.

In conclusion, leadership is a prominent feature of human organizations, but it has not received the attention it deserves in the environmental governance literature. To produce a more nuanced understanding of the evolution of environmental governance institutions, we need to start building and testing theories that articulate the role of specific leadership actions during the different phases of institutional development. Beyond unselfish leadership, what other leadership strategies can help not just with the creation of new institutions, but also with the continued adaptation of existing governance institutions? Such knowledge will be useful to local resource users, policy actors, and scholars as we look for ways to improve the governance of our shared natural resources.

Materials and Methods

Laboratory-in-the-Field Experiment. All eight villages in both countries are located near forests, and all their inhabitants depend to some degree on forest resources for their subsistence. Village authorities announced the "research activity" 1 to 7 d in advance and invited all villagers to participate in the 2-h activity. We made sure members of the same family did not participate in the same group. We also informed participants that participation in the activity was voluntary and that participants were free to discontinue their participation at any point without needing to provide a reason for such withdrawal. Before starting the activity, we conducted a brief survey with all participants, collecting information about basic demographics, values, beliefs, and generalized trust. Field teams initiated the activity by carrying out three to five practice rounds so that all participants understood the game. At the end of the game, we converted the participants' earnings in tokens into local currency. Depending on participants' individual performance in the game, they earned an income equivalent to anywhere between one and one-and-a-half days-worth of local wage labor pay. *SI Appendix*, section 5 provides the full field protocol for the experiment. The University of Colorado's Institutional Review Board reviewed and approved the study's research protocol (13-0198). All participants provided informed consent prior to the start of the activity.

Dynamic Resource. The CPR game design is based on refs. 42, 60, using a dynamic resource with a natural regeneration rate of 20% of the remaining resource stock. This design means that, for every 10 trees left standing in the forest, 2 new trees appear in the next round (never exceeding 100 trees, which is a fully stocked forest). There is a maximum harvesting rule, which depends on the quantity of the remaining resource available, as displayed in *SI Appendix*, Table S1. Because of this rule, it is not possible for a group to deplete the resource entirely. This dynamic resource structure improves the external validity of the design since the participants' experience within the game is relatively similar to their real-life experience with forest resources, whose regeneration rate is conditional on the total stock of the resource.

Nash and Pareto Calculations. With this dynamic structure of the resource availability, the Nash equilibrium equals the maximum allowed harvest for each individual participant, which leads to rapid resource depletion. The Nash strategy returns a total of 22 income units per participant at the end of the game (176 for a group total), The socially optimal harvest (Pareto) strategy is to cut trees at a "sustainable level" (conserving at least 80% of forest stock, which allows natural regeneration to restock the forest for the next round) during the early rounds and then increasing the extraction level by the end of the experiment to increase the final payoff. The Pareto strategy returns on average a total of 66.5 income tokens at the end of the game (or 532 for the group as a whole).

Intercoder Reliability Test. Multiple field assistants (two to three per group) independently coded observations about participant behavior during each of

the 15 rounds per group. We used the observer data to create several variables used in the regression analysis (e.g., Rule Agreement, Leadership, Number of Speakers). We conducted Cohen's kappa tests to evaluate intercoder consistency for these variables. The results suggest high intercoder consistency for these four variables (kappa = 0.84, 0.87, and 0.77; $P < 0.01$ for all variables).

Econometric Modeling Choices. We used regression analysis to study the effect of unselfish leadership on rule agreement. Holding group context constant, we studied what happens to rule agreement when leaders emerge and act unselfishly. Because we were interested in leadership actions that vary over time, we modeled this relationship as a group fixed-effect regression, which allows us to control for contextual variation between groups. As a robustness check, we estimated the effect of leadership on rule agreement using random-effects models. The results of the random-effects regression models (*SI Appendix*, Table S3*A*) are very consistent with the fixed-effect models in the main text. We conducted additional robustness checks using a Tobit model for truncated dependent variables (DVs) (at 0 and 100), which also produced results (*SI Appendix*, Table S3*A*) highly consistent with our preferred estimators, presented in Table 1. We also conducted panel-unit root tests to ensure the stationarity of our main variables, avoiding spurious correlations (*SI Appendix*, Table S5). In *SI Appendix*, section 1, we provide links to all data and code used to produce the main results of the paper.

Data Availability. Code and deidentified data files for Stata 14 and higher data have been deposited in the Harvard Dataverse repository (https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/XKCYQL) (56).

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