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Understanding the Lessons and Limitations of Conservation and Development

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Abstract: *The lack of concrete instances in which conservation and development have been successfully merged has strengthened arguments for strict exclusionist conservation policies. Research has focused more on social cooperation and conflict of different management regimes and less on how these factors actually affect the natural environments they seek to conserve. Consequently, it is still unknown which strategies yield better conservation outcomes? We conducted a meta-analysis of 116 published case studies on common resource management regimes from Africa, south and central America, and southern and Southeast Asia. Using ranked sociodemographic, political, and ecological data, we analyzed the effect of land tenure, population size, social heterogeneity, as well as internally devised resource-management rules and regulations (institutions) on conservation outcome. Although land tenure, population size, and social heterogeneity did not significantly affect conservation outcome, institutions were positively associated with better conservation outcomes. There was also a significant interaction effect between population size and institutions, which implies complex relationships between population size and conservation outcome. Our results suggest that communities managing a common resource can play a significant role in conservation and that institutions lead to management regimes with lower environmental impacts.*

Keywords: conservation, development, meta-analysis, common-pool resource management, land tenure, population size, social heterogeneity

Entendiendo las Lecciones y Limitaciones de la Conservación y el Desarrollo

Resumen: *La falta de instancias concretas donde la conservación y el desarrollo se han combinado exitosamente ha reforzados los argumentos para políticas de conservación excluyentes estrictas. La investigación se ha enfocado más en la cooperación y conflicto social de diferentes regímenes de manejo y poco en cómo esos factores afectan realmente a los ambientes naturales que buscan conservar. Consecuentemente, aun no se conoce qué estrategias rinden mejores resultados de conservación. Realizamos un meta-análisis de 116 casos publicados sobre regímenes de manejo de recursos comunes en África, Centro y Sud América y el sur y sureste de Asia. Utilizamos datos sociodemográficos, políticos y económicos jerarquizados, analizamos el efecto de la tenencia de la tierra, el tamaño poblacional, la heterogeneidad social, así como el de las normas y regulaciones (instituciones) sobre manejo de recursos elaboradas internamente sobre los resultados de conservación. Aunque la tenencia de la tierra, el tamaño poblacional y la heterogeneidad social no afectaron significativamente los resultados de conservación, las instituciones se asociaron positivamente con los mejores resultados de conservación. También hubo una interacción significativa entre el tamaño poblacional y las instituciones, lo que implica relaciones complejas entre el tamaño poblacional y los resultados de conservación. Nuestros resultados sugieren que las comunidades que manejan un recurso común pueden jugar un papel significativo y que las instituciones conducen a regímenes de manejo con impactos ambientales más bajos.*

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Palabras Clave: conservación, desarrollo, heterogeneidad social, manejo de recursos de propiedad común, meta-análisis, tamaño poblacional, tenencia de tierras

Introduction

Meeting economic needs while preventing further environmental degradation and halting biodiversity loss is vital (Pimm et al. 1995; Myers et al. 2000; Mena et al. 2006). Community-based approaches try to fuse economic development, sustainable resource use, and conservation. Sometimes termed integrated conservation and development projects (ICDPs), these initiatives have attempted to reduce tensions between stakeholders, allow communities to participate in decision making, and link use of common-pool resources with conservation.

Despite the popularity of ICDPs, examples of their success are rare (Salafsky et al. 2001). This has led to a resurgence of the protectionist argument, which pits strict conservation against economic development (Hutton et al. 2005). The ongoing debate between those who argue that conservation and development are mutually exclusive (e.g., Terborgh 2000) and those who emphasize the social impact of protected areas (e.g., Brockington & Schmidt-Soltau 2004) highlights the need for a common analytical framework and a reassessment of the multiple approaches to conservation and development (Sunderland et al. 2008).

Recent empirical approaches have examined the efficacy of protected areas in safeguarding biodiversity. Parks are relatively effective at limiting forest degradation (Bruner et al. 2001) and have limited deforestation compared with adjacent buffer zones (DeFries et al. 2005). In parallel, under some economic circumstances ICDPs can achieve development and conservation goals (Salafsky et al. 2001) and implementation of ICDPs can lead to successful socioeconomic development and conservation (Brooks et al. 2006). Nevertheless, how conservation outcomes of ICDPs and common property regimes compare with outcomes of protected areas is still unknown. More is known about social cooperation and conflict surrounding ICDPs than their effects on the natural environment. Hayes (2006) has tackled this issue and found that forests under collective management fare no worse or better than protected areas, but her work was limited by her definition of a protected area (PA), which makes it difficult to compare her results with those of Bruner et al. (2001) and DeFries et al. (2005) (Brockington et al. 2008). Nevertheless, her study provides a step in the right direction.

Institutions constitute one of the most important variables influencing common-pool resource management (Ostrom 1990, 1999; Agrawal 2001). Institutions are formal and informal political structures designed to assist resource management (Ostrom 1990). There is now substantial evidence suggesting that common-pool resources can be well managed when the rules governing their use are designed and enforced by the resource users (Ostrom 1999; Ostrom et al. 2002). The form and function of institutions are strongly related to land tenure, property rights, and social characteristics such as population size and heterogeneity (Agrawal 2001; Agrawal & Ostrom 2001). A better understanding of their dynamics will improve implementation of conservation and development policies (Poteete & Ostrom 2008).

We investigated the relationship between common-pool resource management and conservation. We explored whether collective management can have a positive effect on conservation through the use of published quantitative data. We assessed the effect of individual variables associated with collective action on measures of environmental health.

Methods

We compiled a database of published research on common-pool resource use with information on population size, heterogeneity, and institutional arrangements, all variables that affect use of natural resources. We performed literature searches of commonly used databases and detailed citation and reference searches. We searched for the following terms: *ICDP*, *common resource*, *institutions*, *conservation*, *forest user groups*, and *sustainable resource use*. Our search produced an initial collection of 119 research papers. Of these, 19 contained information on land tenure, population size, heterogeneity, and institutional arrangements and linked one or more of these variables to some measure of environmental health. Each selected research paper included between one and 23 case studies in their analysis, and we compiled a data set of 116 case studies for our analysis. All case studies focused on forest user groups. Studies were from a range of geographical locations, with a strong bias toward studies from southern Asia (Table 1).

We analyzed the data with both quantitative methods and a qualitative comparative analysis (QCA). A QCA relies on binary data and Boolean algorithms to examine different combinations of predictor variables (Ragin 1987). In a QCA, alternate models are based on presence or absence of independent and dependent variables. All possible combinations of predictor variables are tabulated against a particular outcome with the aid of a truth table that reveals combinations of predictors leading to particular outcomes. This allows one to find combinations of predictors leading to the outcome in question; it is

Table 1. Case studies and variables for each study included in our analysis.

Author	*Location*	*Social diversity*	*Population size*	*Institutional arrangements*	*Environmental variable*	*Number of case studies*
Adhikari & Lovett 2006	Nepal	yes	no	yes	forest condition	8 community forests
Balooni et al. 2007	India	yes	yes	yes	tree species composition	2 community forests
Banana & Gombya-Ssembajjwe 2000	Uganda	no	no	yes	illegal activities	1 private forest, 4 government forests
Becker & Gibson 2000	Ecuador	no	yes	yes	forest condition	1 community forests
Becker & Leon 2000	Bolivia	no	no	yes	forest condition	3 community forests
Chakraborty 2001	Nepal	yes	yes	yes	forest regeneration	5 community forests
Gautam & Shivakoti 2005	Nepal	no	no	yes	forest condition	1 community forest, 1 government forest
Jackson et al. 1998	Nepal	no	no	no	deforestation	20 community forests
Johnson & Nelson 2004	Mexico	yes	yes	yes	forest condition	1 community forest
Kabir & Webb 2006	Thailand	no	yes	yes	forest condition	1 community forest
Kijtewachakul 2004§	Thailand	no	yes	yes	tree biodiversity	2 community forests
Nagendra 2002	Nepal	yes	no	no	tree biodiversity	2 community forests
Nagendra et al. 2005	Nepal	no	yes	yes	deforestation	9 community forests, 14 government forests
Pandit & Thapa 2003	Nepal	yes	yes	yes	forest condition	2 community forests
Paule Dalle et al. 2006	Mexico	no	no	no	deforestation	1 community forest
Sauer & Abdallah 2007	Tanzania	yes	yes	no	tree biodiversity	2 community forests, 3 government forests
Tucker 1999	Honduras	no	no	no	tree density and size	2 community forests, 4 private forests
Tucker et al. 2007	Guatemala, Honduras	no	no	yes	forest condition	8 community forests, 3 private forests
Varughese & Ostrom 2001	Nepal	yes	yes	yes	forest condition	18 community forests

particularly useful for the analysis of qualitative social data and environmental change (Rudel 2008). A QCA however, requires complete data sets with no missing values in any of the predictor variables. Although QCA can test for interaction effects by identifying possible combinations of predictor variables, it simplifies these data into binaries (Ragin 1987). To retain as much of the information in the data as we could, we also conducted a quantitative analysis. We used ranked data and an ordinal logistic regression to test for main predictor effects and interaction effects.

Quantitative Analysis

We standardized the data set by converting continuous values into ordinal data. We classified the governance of forests as being under community or noncommunity control, following the description in individual studies. We ranked the population size of user groups as large (>1500), medium (500–1500), or small (<500). Where user groups were only reported as households, we estimated household size from cases having both household and population data.

We classified heterogeneity as high, moderate, or low. Due to a lack of economic data, we only measured heterogeneity in sociocultural terms (henceforth, social diversity). We used published values for studies that used a ranking system to classify social diversity. Where social diversity was measured as a percentage of the population belonging to different castes or ethnic groups, we classed social diversity as low if <33.3% or >66.6% of the total population belonged to one ethnic group and high if >33.3% or <66.6% of the total population belonged to one ethnic group. Otherwise we ranked social diversity as low for users of one caste or ethnic group and high for those with three or more. There were no cases with only two castes or ethnic groups, and no groups were classified as having moderate social diversity.

We ranked institutional arrangements as strong, moderate, or weak. We used the already published values for studies that ranked institutional arrangements. For the remaining case studies, we classified user groups without institutions as having weak institutional ranking, groups with one institution as moderate, and groups with two or more institutions as strong. Under this scheme, communities with a simple set of management rules were deemed to have moderate institutional arrangements, whereas communities with management rules and monitoring schemes were deemed to have strong management regimes.

We ranked conservation outcomes as high, low, or none. We used published values for studies that ranked

Table 2. Results for single-effect and two-variable predictor models predicting conservation outcome for all variables included in our study.[a]

Model	n	R^2	df	χ^2	p	Geographical location of cases[b]
Governance	116 (34)	0.002 (0.0003)	2 (1)	0.492 (0.012)	0.484 (0.914)	SA: 82, SEA: 3, A: 10, LA: 21
Governance (conservation high & low)	53 (11)	0.061 (0.004)	1 (1)	4.263 (0.052)	0.0389[c] (0.819)	SA: 42, SEA: 2, A: 3, LA: 6
Group size	68 (8)	0.008 (0.145)	2 (2)	1.038 (3.567)	0.595 (0.323)	SA: 60, SEA: 2, A: 5, LA: 1
Social diversity	41 (6)	0.003 (0.459)	2 (2)	0.286 (3.819)	0.867 (0.148)	SA: 33, SEA: 2, A: 5, LA: 1
Institutional ranking	82 (22)	0.103 (0.208)	2 (2)	16.811 (6.951)	0.0002[c] (0.031)[c]	SA: 60, SEA: 3, A: 5, LA: 14
Model effect	82	0.112	5	18.336	0.0026[c]	SA: 60, SEA: 3, A: 5, LA: 14
governance			1	0.038	0.845	
institutional ranking			2	14.785	0.0006[c]	
governance × institutional ranking			2	0.714	0.699	
Model effect	61	0.232	8	28.535	0.0004[c]	SA: 58, SEA: 2, LA: 1
group size			2	10.294	0.0058[c]	
institutions			2	9.284	0.0096[c]	
Group size × institutional ranking			4	11.983	0.017	

[a] *Numbers in parentheses are results from the analysis in which cases from southern Asia were removed.*
[b] *Key: SA, southern Asia; SEA, Southeast Asia; A, Africa; LA, Latin America.*
[c] *Significant.*

forest health. For studies in which land-cover change was measured on a continuous scale, we classified cases as having no conservation value if degradation rather than reforestation occurred. We classified values between 0% and 5% reforestation as low and values over 5% as high. For studies in which tree density and diversity data with controls were used, we calculated net density and diversity values as percentage of change relative to controls and ranked them as having no conservation value if the percentage was under 0%, low if they were between 0% and 5%, and high if they were over 5%.

All the selected studies did not collect all the social variables included in our analyses. We analyzed all effects in separate models to preserve power, but we also constructed a correlation matrix between predictor variables and constructed two variable-predictor models for predictors with positive relationships. We analyzed the relationship between predictor variables with Spearman ranked correlations and used ordinal logistic regressions to look at single-effect and two-variable predictor models. We tested parameters with likelihood ratio tests against a chi-square distribution. We set statistical significance at $p \leq 0.05$ and ran all statistical tests in JMP 7 (SAS Institute 2007). To correct for the southern Asia bias, we removed those studies and ran the analysis with the remaining cases. Their removal dramatically reduced the sample size. Effects were thus analyzed only in single-effect models.

Qualitative Analysis

Discarding cases with missing values effectively removed all noncommunity forests from the analysis. Of the remaining 36 cases studies, 33 were in southern Asia, two in Southeast Asia, and one in Latin America. User group size was split into two categories, large (>750) or small (<750). High and medium social diversity and strong and moderate institutional ranking were pooled. We classified conservation outcomes as either negative (no conservation outcome) or positive (low and high conservation outcome). Outcomes for nonexistent or contradictory combinations of predictor variables were treated conservatively and coded as negative. The conservation outcome (S) was calculated with the following Boolean equation:

$$S = U + D + I$$

where U is the size of the user group, D is social diversity, and I is institutional ranking. We used a truth table in fsQCA (Ragin et al. 2006) (Table 2). We were unable to control for the regional bias toward southern Asia case studies in the QCA because of small sample sizes.

Results

Correlation and Regression Analysis

Controlling for regional bias toward southern Asia resulted in a similar pattern to the one exhibited by the full data set (Table 2). We thus focused our interpretation of the analysis on the full data set.

The correlation matrix between predictor variables showed that only governance and institutional ranking ($r^2 = 0.063, p = 0.004$) and size of the user group and institutional ranking were positively related ($r^2 = 0.091$, $p = 0.012$). We therefore constructed two variable predictor models with these combinations of variables (Table 2). Governance had no significant effect on

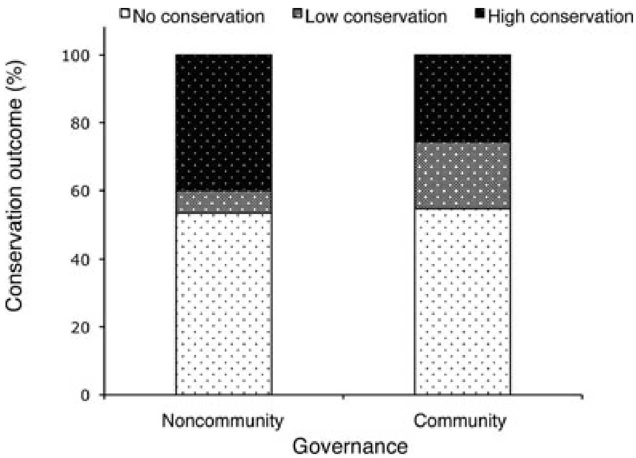

Figure 1. Regression results for the effect of governance (community and noncommunity) on conservation outcome. Conservation outcomes are represented as relative percentages of case studies in each classification of governance.

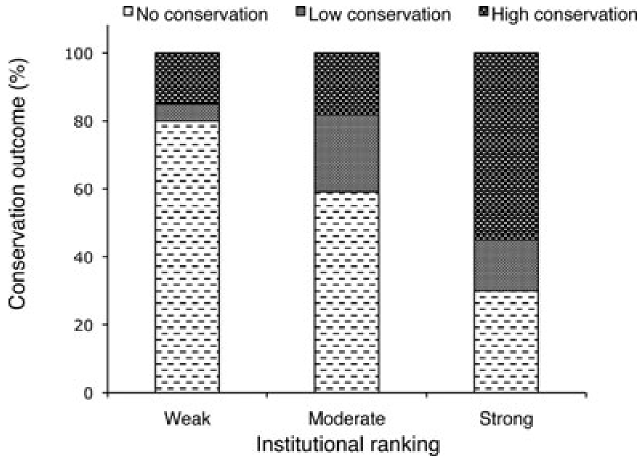

Figure 2. Regression results for the effect of institutional ranking (strong, moderate, and weak) on conservation outcome. Conservation outcomes are represented as relative percentages of case studies in each classification of institutional ranking.

conservation outcome in models with a single predictor variable ($p = 0.483$, see Fig. 1) or with two predictor variables ($p = 0.845$). Of all community forests, 54.6% had no positive conservation outcomes, and 53.3% of noncommunity forests had no successful conservation outcome. Governance did, however, have a significant effect on the degree of conservation outcome when conservation did occur ($p = 0.039$, see Fig. 1). Conservation outcome was substantially higher in noncommunity forests than community forests. Forty percent of successful outcomes in noncommunity forests were high, whereas only 25.5% of outcomes in community forests had high conservation values.

Institutional ranking had a highly significant effect on conservation outcome in single-variable models ($p = 0.0002$, see Fig. 2) and when it was included with governance ($p = 0.0006$) and user group size ($p = 0.0058$). User groups with moderate institutional arrangements had low conservation outcomes in 22.7% of cases and high conservation outcomes in 18.2%. User groups with strong institutional arrangements had 15% low conservation outcomes and 55% high conservation outcomes. In contrast, user groups with weak institutional arrangements had 80% of forests with no positive conservation outcomes and 5% with low conservation outcomes. Although there was no significant interaction effect between governance and institutional ranking ($p = 0.699$), there was a significant interaction effect between user group size and institutional ranking ($p = 0.0179$, see Fig. 3).

Size of the user group had no significant effect on conservation outcome when it was included as a single variable in the model ($p = 0.595$), but it was significant when it was included in conjunction with institutional ranking ($p = 0.0058$). Social diversity had no significant effect on conservation outcome ($p = 0.866$).

Qualitative Comparative Analysis

The solution for the truth table was $S = I$, which implies that institutional ranking is both a necessary and sufficient condition for positive conservation outcomes (Table 3). Thus, presence or absence of a large user group or high degrees of social diversity did not influence conservation success and institutions alone were the key component dictating conservation outcome.

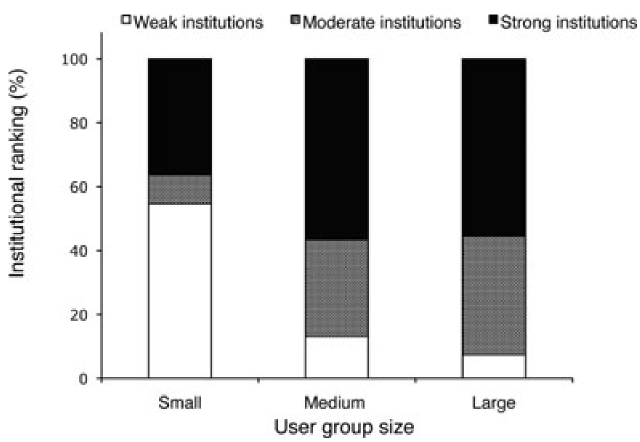

Figure 3. Regression results for the effect of user group size (large, medium, and small) on institutional ranking. Institutional rankings are represented as relative percentages of case studies in each classification of user group size.

Table 3. Quantitative comparative analysis truthtable for conservation outcome in community forests.

User group size (U)	*Social diversity (D)*	*Institutional ranking (I)*	*Cases with negative conservation*	*Cases with positive conservation*	*Conservation success (S)*
0	0	0	3	0	0
1	0	0	–	–	0
0	1	0	4	1	0
0	0	1	0	3	1
1	1	0	1	1	0
1	0	1	1	4	1
0	1	1	1	4	1
1	1	1	1	14	1

Discussion

Governance and Institutions

Missing values precluded QCA of governance, but regression results suggest that governance had no significant effect on the likelihood of conservation success. This confirms previous findings that the devolution of property rights has no clear relationship to degradation (Agrawal & Yadama 1997; Somanathan et al. 2005; Hayes 2006). Although there was no significant effect of governance on likelihood of conservation success, in the presence of conservation success governance had a significant influence on degree of this success. Most studies presented little information about geographical differences (e.g., access to roads or markets) between community and noncommunity forests. These factors affect land use by influencing migration, employment, and agricultural production. They could explain some of the differences in degree of conservation success between management regimes (Geist & Lambin 2002). One factor that potentially explains some of the observed differences is the large number of noncommunity forests included in forests set-aside for conservation (e.g., Sauer & Abdallah 2007). Community forests, however, were all used as a common-pool resource, where regeneration rates might be dampened by resource use.

Results from the QCA and the ordinal regression showed that institutional arrangements had a significant positive effect on conservation success. These results validate previous findings, stressing that institutions positively affect conservation outcomes of common-pool resource management regimes (Ostrom 1990; Agrawal & Yadama 1997; Gibson et al. 2005; Agrawal & Chhatre 2006). Regression analysis showed no significant interaction effect between institutional arrangements and governance, which suggests governance is not a prerequisite for a functional set of institutional arrangements.

Heterogeneity and Group Size

Heterogeneity and group size influenced the number of interactions within a group, which affected relationship building and trust. Individuals in smaller groups might be more willing to work collectively because they believe their contribution will matter. If collective benefits are dispersed over a large group and are less visible, incentives to contribute diminish (Poteete & Ostrom 2004). Therefore, high heterogeneity and large group size should negatively affect collective action and conservation that depends on it. Nevertheless, our results suggest that social diversity has no effect on conservation outcome. Somanathan et al. (2005) found no effect of social diversity on indicators of collective action or forest crown cover in India. Similarly, Varughese and Ostrom (2001) found no effect of social diversity on the health of commonly held forest plots in Nepal.

The effect of group size was only significant in combination with institutional ranking in a model with two predictor variables, which suggests that the effect is not particularly strong. Results from other studies suggest a more complex, nonlinear relationship between group size and collective action. The findings of Nagendra et al. (2005) and Balooni et al. (2007) support the view that larger groups tend to be more efficient at protecting their forests. Agrawal and Yadama (1997) found a significant effect of group size on both forest health and the group's ability to hire a guard. They argue that larger groups might more easily collect funds to cover the cost of monitoring than smaller groups. If, however, the group is too large, then transaction costs can become a limiting factor. Agrawal and Goyal (2001) found the relationship between group size, number of meetings per year, and household contributions is nonlinear. Groups that were either very large or very small met less frequently and had less money available to invest in monitoring initiatives.

No definitive link between social diversity and conservation has been found in the majority of studies focusing on heterogeneity. Balooni et al. (2007) suggest that social diversity has a negative effect on the decision-making process of forest councils and ultimately leads to a decline in forest health. Johnson (2001) observed that causality of the relationship between heterogeneity and collective action can work both ways: the former can become the dependent variable, the latter the independent variable. He noted that heterogeneous fishing communities in Thailand became united and more homogenous because of the need to develop effective institutions to exclude unwanted visitors. Their differences mattered less in the face of a common threat. Several authors argue that the effects of heterogeneity and group size on common-pool resource health are buffered by the creation of institutional arrangements (Agrawal & Yadama 1997; Poteete & Ostrom 2004).

Disentangling the relationship between heterogeneity and group size and how they affect conservation outcomes will require larger sample sizes and more detailed analyses than ours. This work could usefully explore case studies beyond South Asia. Of the 68 case studies with information on the size of user groups, 55 were from Nepal. Similarly, 33 of the 41 cases with data on social diversity were also from Nepal. Finally, investigations into the effects of heterogeneity and group size will need to be nested within frameworks that take into account the large-scale political differences between the countries the groups are in. Nelson and Agrawal's (2008) recent regional comparison of community-based natural resource management in sub-Saharan Africa found that, at the country level, basic issues of the relative value of wildlife and central state performance and corruption were key to explaining the relative success or failure of similar schemes in different countries, before issues of group size and heterogeneity are considered.

Conclusion

We sought to merge the available data on conservation outcomes with data on social characteristics of individual communities. We wanted to contribute to the current debate on relative merits of excluding or including people in conservation initiatives. At first glance, our results provide evidence to suggest that forests under community management can lead to positive conservation outcomes. The results also highlight the importance of strong institutions managing use.

Any analysis relying on the amalgamation of a collection of studies, however, is inherently constrained by the data available and their biases. Although results controlling for geographical bias showed a pattern similar to the full data set, without studies from southern Asia our sample size was small, which casts doubt on the broader representativeness of our results. Although regional bias highlights the need for geographically diversified studies linking common-pool resource regimes to environmental impacts, it might also highlight regional differences in forest governance structures (Rudel 2005). Introduction of the Community Forest Act in Nepal (Nagendra 2002) and creation of Forest Councils in India (Agrawal & Ostrom 2001) represent conscious moves toward decentralization and more localized, autonomous conservation policies. Furthermore, the common-pool resources in question in all cases in the analysis were forests. Lack of study of other common-pool resources brings into question whether our results also apply to other common-pool resource regimes. Any meta-analysis is limited by the variables that individual studies select and the way in which these variables are measured (Rudel 2008). That said, and despite the difficulty of conducting multivariate analysis due to the high number of possible confounding variables and their interactions, meta-analyses are useful for identifying recurrent trends and discerning possible interactions (Agrawal 2001).

Our combination of qualitative (QCA) and quantitative methods highlighted a significant link between institutions and positive conservation outcomes. The relationship between humans and the environment, however, is not linear and can be better described as a network of complex feedback loops (Liu et al. 2007). Although we assumed a linear relationship between institutions and conservation outcomes, case-specific reality will not be as simple as implied here. Future studies should thus strive to understand how environmental changes (positive or negative) affect the evolution of institutions.

Long-term international research efforts such as the International Forestry Resources and Institutions (IFRI) attempt to bridge the gap between collective action and environmental impacts. Although these studies have helped elucidate recurrent trends, there are still little comparative quantitative data (Poteete & Ostrom 2008). This is not only exemplified by the small number of case studies linking group characteristics to the health of a common-pool resource, but also by the variables used to assess conservation outcomes and interpretations from analyzed data. For instance, one study that links socioeconomic data to forest health relied on user groups' own assessment of their forest as measures of success (Agrawal & Yadama 1997); another used assessments by park staff of their own park (Bruner et al. 2001). Although the indices of resource health used in the two studies might yield rough estimates of forest condition, they are susceptible to individual biases and do not give any detailed information on ecosystem processes and whether they are being preserved.

Although our results add credence to the already existing evidence that suggests that community-managed forests can yield successful conservation outcomes, they also highlight the lack of data relating social, demographic, and economic factors to biologically relevant measurements of biodiversity and conservation. If the conservation outcomes of community-centered conservation projects are to be accurately compared with protected areas, it is imperative to understand how communities and collective action affect ecosystems and natural processes. Systematic, large-scale studies such as the Millennium Ecosystem Assessment are proof that it is possible to establish large research networks aiming to answer different facets of the same underlying question. Although efforts such as the IFRI provide steps in the right direction, there is still a need for more coordinated and systematic approaches.

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