Drivers of reforestation in human-dominated forests

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Tropical forest habitat continues to decline globally, with serious negative consequences for environmental sustainability. The small mountain country of Nepal provides an excellent context in which to examine trajectories of forest-cover change. Despite having experienced large-scale forest clearing in the past, significant reforestation has taken place in recent years. The range of biophysical and ecological environments and diversity of tenure arrangements provide us with a context with sufficient variation to be able to derive insight into the impact of a range of hypothesized drivers of forest change. This article draws on a dataset of 55 forests from the middle hills and Terai plains of Nepal to examine the factors associated with forest clearing or regeneration. Results affirm the central importance of tenure regimes and local monitoring for forest regrowth. In addition, user group size per unit of forest area is an important, independent explanator of forest change. These variables also can be associated with specific practices that further influence forest change such as the management of social conflict, adoption of new technologies to reduce pressure on the forest, and involvement of users in forest maintenance activities. Such large-N, comparative studies are essential if we are to derive more complex, nuanced, yet actionable frameworks that help us to plan better policies for the management of natural resources.

community forestry | group size | institutions | monitoring | Nepal

In recent decades, humankind has witnessed unprecedented destruction of forest cover, with its accompanying fallout on global climate, health, biodiversity, air quality, soil fertility, water flow, and other environmental variables. Deforestation also impacts the lives and livelihoods of the many millions of forest-dependent inhabitants around the world. Awareness of the extent of forest clearing and the magnitude of the ensuing problems have led communities, governments, and international organizations to create an array of protection mechanisms that range from government-owned protected areas to private conservation parks and community reserves. These plans have had mixed success, and it is difficult to unambiguously attribute success or failure to a specific formal mechanism (1, 2). Yet, conservation organizations, indigenous communities, and policy makers continue to engage in often heated debates concerning the presumed single best approach to conserve forest biodiversity (3).

The remarkable dearth of reliable large datasets on forest change only exacerbates the already heated deforestation debate. Until recently, estimates by the Food and Agricultural Organization of the United Nations were used for most global studies. These data are based on information provided by government agencies in >200 countries and have been strongly criticized for providing an inaccurate picture complicated by variations in methodology and frequently changing baseline definitions of forest (4). More reliable assessments of rates of tropical deforestation have been provided in the recent *Global Forest Resources Assessment* (ref. 5 and www.fao.org/forestry/site/fra/en) and from large-scale satellite image studies by Achard *et al.* (6) and DeFries *et al.* (7). Although these authors provide somewhat different estimates of global forest change, they agree on the point that massive deforestation continues in the tropics.

These reports have alarming implications. The dependence of rural communities on the biodiversity, ecological processes, and ecosystem services provided by tropical and subtropical forests is far greater in magnitude than in the temperate zone (8), yet it is precisely these areas where forest cover is fast disappearing. For the hundreds of millions of poor, forest-dependent, rural inhabitants in these areas, the losses in forest cover have had particularly severe consequences. Yet, a growing body of recent literature suggests that there has been a reversal in this trend in several tropical and subtropical regions (9–11). This reforestation is often patchy, with tropical forest landscapes typically consisting of a multiple-use mosaic of remnant forest patches, disturbed multiple-use forests, and regenerating areas that also support habitation, agriculture, and livestock grazing (9). Rates of forest recovery are typically slower than initial rates of clearing, and these emerging forests often do not contain the same species or supply the same range of ecosystem goods and services provided by less-disturbed forests (12). Nevertheless, secondary forests provide important environmental services that assist efforts toward sustainable development, increase carbon sequestration, assist in soil conservation and stabilization of hydrological cycles, and increase overall biodiversity levels (7, 10).

Developing a good understanding of factors that can help to encourage such reforestation is critical if we hope to encourage forest regrowth and arrest or reverse deforestation. Whereas the driving forces associated with forest transitions have been well documented in economically developed countries in the temperate world, such as Scotland, France, and the United States (13), drivers of reforestation in tropical developing countries are less studied. Nevertheless, there is growing evidence of large-scale forest regrowth in the tropical and subtropical forests of Brazil (14), Costa Rica (15), India (16), Mexico (17), Nepal (18), Puerto Rico (12), and Tanzania (19). Developing a more comprehensive understanding of the range of proximate and underlying factors that can help promote reforestation in human-dominated forests is essential if we are to develop useful policy interventions.

This article draws on a dataset from Nepal to conduct an examination of the factors that are significantly associated with forest change. This small mountain country provides an excellent context in which to examine trajectories of forest change, with extensive evidence of forest clearing in some regions and large-scale regrowth in others (18, 20). The range of biophysical and ecological contexts, diversity of tenure arrangements, and number of user groups provide us with sufficient variation to be able to examine a range of contexts. We draw on this dataset to evaluate a range of hypothesized drivers of forest change and identify the significant variables that appear to impact whether forests change in the direction of clearing or regeneration in this region.

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Drivers of Reforestation

Discussions of tenure regime are essential to an understanding of forest-cover change (21). Unfortunately, heated exchanges have occurred on this topic, and many rigid positions have been adopted that do not appear to be supported by exhaustive comparative studies. Many conservation biologists have argued that strict conservation areas are essential for the protection of forest habitat. Some cross-site studies indicate that government-protected areas have succeeded in achieving their conservation objectives (22, 23). Other studies compare strict government protection with other tenure arrangements and indicate that management by local communities can be just as effective (24, 25). Yet, all communities are not equally effective (26). Whereas community forestry has been linked to large-scale reforestation in Nepal (20) and Mexico (17), the large-scale, forced implementation of collective forestry in China in the 1950s has not prevented the sharp decline in the quantity and quality of that country's forests (27).

Changing formal tenure regimes through policy reforms is not sufficient, unless practices of forest management change on the ground and can otherwise lead to governance failures (28). Although the importance of understanding local social, cultural, and institutional contexts is acknowledged by policy makers, in practice, conservation projects are often designed and implemented by conservation biologists and natural resource managers with little or no input from anthropologists or other social scientists other than economists (3, 29). In some cases, this type of approach leads to ill-conceived and hasty promotion of community development by external government or nongovernment organizations, which can exacerbate preexisting inequities, often leading to the further concentration of power in the hands of local elite. The resulting outcomes can be quite contrary to stated objectives of conservation and social development (29, 30).

In addition to tenure regimes, a large number of biophysical, ecological, social, institutional, and economic variables have been identified with the success or failure of natural resource management initiatives (31–33). These variables can be grouped broadly into attributes of the resource system and its units (in this case, forests and trees), the users of the system (local communities that use extractive and nonextractive benefits from this forest), and the governance system adopted by the users (26). Forests are embedded within larger-level socioeconomic and political settings, which also have the capacity to significantly influence outcomes (34).

Given the plethora of variables identified in different studies as being relevant to successful management of forest resources, there is a need for cross-site empirical studies examining the relative impact of some of these variables in experimental laboratory settings or in field contexts. Cross-site studies will enable us to assess the relative importance of variables in a range of different contexts (2). The large datasets that would seem to be required to enable simultaneous examination of all relevant variables are rare, if not practically impossible to obtain. Even if they exist, they would pose rather severe analytical challenges to researchers (31).

Fortunately, examination of all possibly relevant variables is not required. A diagnostic approach can help narrow the larger set of potential variables to identify specific factors that are important in a given context. Market prices may be more important in some contexts than others. Biophysical variability may assume significance in mountain contexts (35, 36), but in relatively flatter regions where topography is relatively homogeneous, other ecological factors may assume greater significance (37). Several potential predictive variables also may be correlated, enabling further compression of the set of independent, driving variables.

Thus, the limiting factor is not the lack of a database large enough to examine all variables that have been identified in previous contexts as possibly being relevant but, instead, the lack of a diagnostic approach that prioritizes the variables that determine which questions are relevant in a given context (34). Theoretically motivated examinations of literature can be used to distill the complex set of potential driving factors and focus on variables that are the most important in different contexts, achieving clarity without sacrificing relevant detail. The development and use of such diagnostic frameworks is necessary if we are to go beyond simplistic panaceas that focus solely on official tenure regimes, and identify relevant factors impacting the successful management of forests in a variety of institutional, ecological, and social settings (2).

Forest Change in Nepal

The extent of tropical forest habitat in the Himalayas continues to decline, with serious negative consequences in store for climate change, soil, land stability, biodiversity, and the ecological sustainability and economic survival of the people dependent on the forests (38). Since the early 1970s, Nepal has proved a forerunner in implementing a variety of community-based policies of forest management (20). Conflicts arising from the Maoist insurgency have had serious adverse impacts on forest management over the past decade. Yet, the impact has been more severe on government-owned protected areas, and many community institutions have survived the conflict (although perhaps at reduced levels of activity) because of popular support at the grassroots level (39, 40).

The biodiverse Nepal landscape supports some of the world's highest population densities and represents a complex tension between people and nature. There has been considerable discussion of the trajectory of land-cover change in the region. Scholarly discussions of the direction and causes of the land-cover change have varied considerably over the last four decades (41). In the mid-1970s, what was subsequently termed the "theory of Himalayan degradation" received wide publicity, with the hypothesis that deforestation in the Himalayas was rapidly reaching catastrophic proportions because of population increase (summarized in ref. 42). Predictions were made that all accessible forests in the hills of Nepal would disappear by the year 1995 and in the Terai by 2000.

Fortunately, this model of unilateral forest clearing is now believed to be overly simplistic and exaggerated (41). The rich social, ecological, physical, and cultural heterogeneity in the region makes it difficult, if not impossible, to generalize trends across the entire country and identify a single linear trajectory of land-cover change. In the middle hills, where the population densities are the highest, there has been little reduction in forest cover since the early to mid-20th century, although there has been considerable deterioration in the quality of forest habitat and in wildlife populations (20). Major losses in forest cover have occurred in recent decades, but in the lowlands of the Terai, not in the hills (37, 43). Thus, a simple model of unidirectional land-cover change from forest to agriculture, caused by population increase, fails to adequately describe the complexity of land-cover change in this highly varied socioculturally and biophysically complex mountain region. It also fails to take into account the diverse array of institutional responses that communities are capable of when faced with such change (35, 43).

The International Forestry Resources and Institutions (IFRI) Research Program in Nepal

Data used for this article come from a larger dataset on institutions and forests collected by Nepal Forestry Resources and Institutions, using the IFRI research program. Coordinated by the University of Michigan and Indiana University, this program is currently active in 13 countries across North America, Africa, Asia, and Latin America (2). The program comprises a set of 10 research protocols, used to obtain comprehensive information in a standardized format on user groups, attributes of forest governance, and the ecological condition of forests accessed by these users.

The IFRI program has been active in Nepal for more than a decade and provides a large and valuable database that can be used to evaluate a range of factors that have been identified as impacting forest condition positively or negatively. In the few instances where

Table 1. An initial set of 17 variables identified as potentially significant drivers of forest clearing and regrowth in Nepal

Attributes of			Relationship between	
Resource	User group	Governance system	User group and resource	Governance system and resource
Steepness Forest size Forest condition	Group size Population density (group size per unit of forest area)	Tenure regime Monitoring Social capital Significant disruptive conflict Leadership Involvement of users in making the rules	Distance of settlement from forest Level of dependence on forest	Vegetation planting Forest maintenance Adoption of new technologies that reduce pressure on the forest Regulation of pressure by harvesting outside the forest

a given forest was studied at two different points in time, data from the most recent time point were used. A subset of data from 55 forests was used for analysis. Data for other forests missed information on one or more variables and were excluded from further analysis, an unfortunate problem frequently encountered by researchers conducting large-N studies (26). Whereas these forests do not represent a random sample, they nevertheless provide data from a range of forest habitats in the Nepal Terai plains and middle hills, excluding only the high hills, which are mainly beyond the tree line.

Identifying Variables

An initial set of variables was identified from previous large-N studies of forest commons (1, 2, 26, 31, 32, 35). Based on several years of research in Nepal (18, 37, 44, 45), this set of variables was narrowed down to a subset of 17 variables that were identified as potentially impacting the success of forest management initiatives in Nepal (Table 1). The variables were grouped into five sets: (*i*) attributes of the resource system, (*ii*) attributes of the user group, (*iii*) attributes of the governance system, (*iv*) attributes relating to interactions between the user group and resource, and (*v*) attributes relating to interactions between the governance system and the resource. Variables related to the socioeconomic and political settings within which these forests are embedded were omitted from consideration, because the settings are broadly similar. The supporting information (SI) *Appendix* provides further details of the measurement of the 17 potential drivers of forest change.

The dependent variable of interest is the change in forest density. Ideally, it would be best assessed by using quantitative information on forest biodiversity, biomass, density, or other determinants of forest condition at two points in time. Although the IFRI database is steadily growing to include a set of revisited sites for which such analyses can be conducted (2), the majority of sites for which data are available currently provide forest plot data from a single point in time, enabling assessment only of current forest conditions. Users were asked to provide an assessment of changes in tree, bush, and ground-cover density over the past 5 years. Information on all three variables was combined to produce a composite three-point index that evaluates whether forest density has increased, stayed the same, or decreased over time.

Interrelationships and Independent Factors

The subset of 17 independent variables listed in Table 1 is too large to enable independent examination of their relationship to the direction of forest change, using a database of 55 forests. As a next step, correlations between these variables were examined. The forest tenure regime or management category is the major independent variable of interest, because so much of the discussion around the management of forest resources has focused on this attribute. All forests in Nepal are owned by the government, so ownership cannot be used to categorize forest governance in this context. The IFRI forests in Nepal fall largely within three tenure regimes, based on the official categorization of their management practices.

The first category comprises national forests, which are managed by the government forest department in principle, but in practice are often used as open-access forests that may occasionally be monitored by forest guards. In the second category, community forests are managed by local communities organized into community forestry user groups. This program is now widespread in the Nepal middle hills and Terai plains and is commonly believed to have been successful in reversing much of the deforestation in the middle hills, although there has been wide variation in its implementation in different parts of the country and the program is not without its share of problems (20, 37).

In the third category, the leasehold forestry program was implemented in Nepal to provide small areas of highly degraded forest land, often located in steep, less accessible areas, to a small number of poor households. This program has been critiqued in a number of studies for its inability to reduce social conflict or alleviate poverty (e.g., refs. 45 and 46); yet its impact on forest change has not been systematically studied so far. The database examined in this article consists of 12 national forests, 25 community forests, and 18 leasehold forests.

Although forests within a tenure regime are managed according to similar guidelines, this grouping may mask additional variation within regimes; much of this variation, however, can be described by the additional variables listed in Table 1. Because tenure regime is a central variable of interest, other variables were examined to see whether they showed significant associations with tenure regime (Table 2; all tests conducted by using a one-way ANOVA with a cut-off significance of $P < 0.05$). Significant associations were observed between tenure regime and all three identified attributes of the resource: steepness of the terrain, forest size, and forest condition (as assessed by an independent, experienced forester accompanying each research team, who was not provided with information on the objectives of this study). On average, leasehold forests were smaller in area, were located on steeper terrain, and had forests in poorer initial condition compared with the other two categories.

Significant associations were also observed between tenure regime and most variables that describe attributes of the relationship between the resource and the governance system, except for the variable related to forest maintenance. Compared with leasehold forest users, community forest users are more apt to adopt new technologies to reduce pressure on the forest; national forest users almost never use new technologies. Leasehold forest users tend to limit usage of their forests by harvesting forest products from other communal or government forests. These groups also engage in more planting compared with community forest users; users of national forests rarely, if ever, do so.

Tenure regime was significantly related to group size and forest dependence: Leasehold forest users had the smallest group size and depended the most on the forest, which is not surprising, considering that a small number of such families are selected from the

Table 2. Significance of one-way ANOVA tests to examine associations between tenure regime and other attributes

Attributes of			Relationship between	
Resource	User group	Governance system	User group and resource	Governance system and resource
Tenure regime and steepness of terrain: $P = 0.022$*	Tenure regime and group size: $P < 0.000$*	Tenure regime and monitoring: $P = 0.011$	Tenure regime and distance of settlement from forest: $P = 0.282$	Tenure regime and vegetation planting: $P < 0.000$*
Tenure regime and forest size: $P < 0.000$*	Tenure regime and group size/forest area ratio: $P = 0.109$	Tenure regime and social capital: $P = 0.581$	Tenure regime and dependence on forest: $P < 0.000$*	Tenure regime and forest maintenance activities: $P = 0.208$
Tenure regime and forest quality: $P = 0.002$*		Tenure regime and disruptive conflict: $P = 0.020$*		Tenure regime and adoption of new technologies that reduce pressure on the forest: $P = 0.007$*
		Tenure regime and leadership: $P = 0.185$		Tenure regime and regulation of pressure by harvesting outside the forest: $P = 0.026$*
		Tenure regime and involvement of users in making the rules: $P = 0.935$		

*Significance at $P < 0.05$.

poorest families for inclusion in the leasehold forestry program. Tenure regime was also significantly associated with social conflict. In line with earlier reports (45, 46), leasehold forest groups reported the highest number of disruptive conflicts. Tenure regime was not significantly associated with any other attributes of the governance system, indicating that these variables represent independent additional factors that need to be considered separately.

Based on the above analysis, all factors significantly associated with the tenure regime were omitted from further consideration, which leaves us with a set of eight variables: tenure regime, distance of settlement from the forest, group size/forest ratio (number of users relative to the forest area), monitoring, social capital, leadership, involvement of users in making rules, and involvement in forest maintenance. Although this set is substantially smaller than the original group of 17 variables, it is still too large to systematically examine for associations, given the sample size of 55 forests. Monitoring is another potentially very significant variable; a number of other studies using the IFRI database, as well as other large-N studies on the commons, have demonstrated the significance of this variable (2, 26, 32, 47–51). Effective monitoring has been shown to be associated with a host of other actions by user groups that indicate the forest is well patrolled and guarded against infractions, rule compliance is ensured, and infraction is dealt with by sanctioning offenders.

The reduced variable set was examined more closely to assess whether any variables were further associated with monitoring. The frequency with which users met for monitoring and/or sanctioning activities was assessed following in-depth interviews with user groups. Users were categorized into four groups: users who meet year round, seasonally, occasionally, or never. Results indicate that the degree of monitoring is significantly associated with settlement distance from the forest ($P = 0.008$), social capital ($P < 0.000$), involvement of users in making rules ($P < 0.000$), and involvement of users in forest maintenance ($P < 0.000$). Removing these four variables results in a set of four independent, potential explanators of forest change: tenure regime, monitoring, user group/forest ratio, and leadership. No association was expected, or found, between leadership and the group/forest ratio.

This exercise provides some insight into the interrelationships between a number of variables that have been identified as impacting the success or failure of natural resource management. Whereas dozens of variables have been listed in hundreds of case studies (see summaries in refs. 1, 26, 31, 32, 34, and 52), several of them may act in conjunction. There is theoretical justification for monitoring and social capital to be correlated (32). Other relationships may not be as apparent and will vary depending on context. In this dataset from Nepal, topography and tenure regime are related, with leasehold forests located on significantly steeper slopes compared with community and national forests. Similar results have been demonstrated by several researchers (36, 53) in Honduras and Guatemala, where forests on steeper slopes are more likely to be managed by common-property institutions compared with private-property institutions. In these three locations, a plausible hypothesis is that forests located in steeper areas are in less demand and can be more easily acquired by communities (see also ref. 37). This scenario may not be present in other locations, and will depend on local- and regional-scale factors.

Associates of Reforestation

The four identified independent variables were examined for associations with change in forest density (the dependent variable), using a one-way ANOVA ($P < 0.10$). No significant association was observed between leadership and change in forest density ($P = 0.455$). Tenure regime, user group/forest ratio, and monitoring were associated with the direction of forest change, in decreasing order of significance. Figs. 1–3 show the relationship between these variables and the direction of forest change.

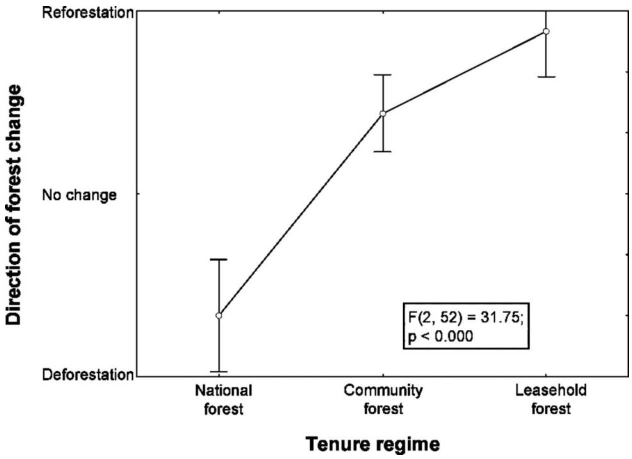

Fig. 1. Results of a one-way ANOVA examining the association between tenure regime and changes in forest condition. On the *y* axis, 1 represents a decrease in forest density, 2 represents no change, and 3 represents an increase in forest density. Vertical bars denote 0.95 confidence intervals.

Tenure regime is significantly associated with forest change ($P < 0.000$). Leasehold forest users, despite being provided with small, degraded forest patches at steep locations and the high degree of disruptive conflict with their neighbors, have nevertheless achieved substantial increases in forest density compared with national forest groups (Fig. 1). This change may in part reflect the highly degraded state in which they receive their forests and the high levels of planting in these forests, but it is nevertheless impressive. Community forest users also have had a positive impact on their forests, but less so when compared with leasehold users. However, leasehold forest users are also significantly more likely to curtail use of their own forest resources by shifting their harvesting requirements to nearby national or communal forests, whereas community forestry users are the least likely to do so. Community forests are also much larger than leasehold forests. Thus, at a landscape scale, community forest users may actually have a greater net impact on reforestation in Nepal.

Monitoring is also significantly related to changes in forest density (Fig. 2; $P = 0.094$). Interestingly, even occasional monitoring can have a significant positive impact, but the possibility of achieving regrowth drops dramatically as local monitoring ceases completely. This analysis indicates the need to examine local monitoring in greater temporal detail than has been done in other

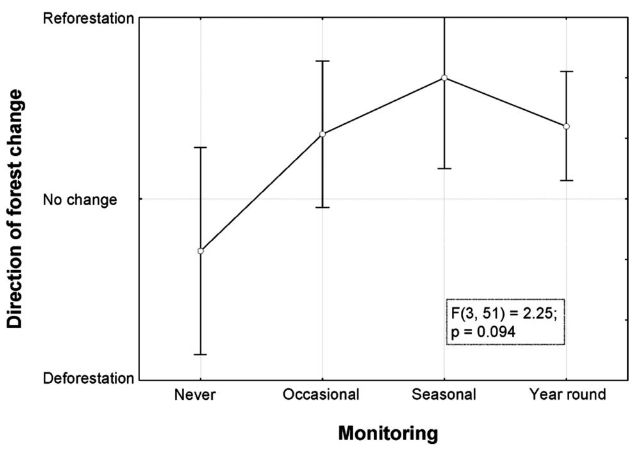

Fig. 2. Results of a one-way ANOVA examining the association between monitoring and changes in forest condition. *y*-axis values and vertical bars are as defined in the Fig. 1 legend.

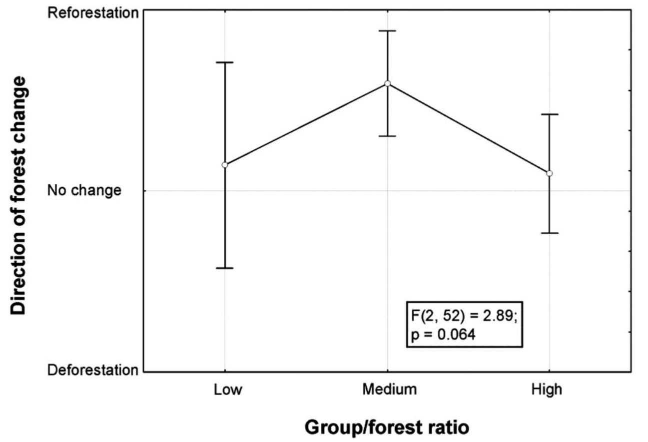

Fig. 3. Results of a one-way ANOVA examining the association between the user group/forest ratio and changes in forest condition. *y*-axis values and vertical bars are as defined in the Fig. 1 legend.

studies using the IFRI database, where occasional monitoring is grouped with lack of monitoring (2, 25). The analysis here indicates clearly that even occasional monitoring and sanctioning is enough to create a strong positive impact on the forest.

The user group/forest ratio is significantly related to forest change ($P = 0.064$), but with a curvilinear relationship (Fig. 3). When the ratio is too low (<5 individuals per hectare of forest area) or too high (>15 individuals per hectare of forest area) relative to the size of the forest, forest density tends to decline. However, at intermediate group sizes (5–15 individuals per hectare of forest area), forest regeneration is maximum. Similar relationships have been demonstrated in previous studies in South Asia (18, 35, 54, 55). When the number of users is too few relative to the total forest area, forest planting, maintenance, monitoring, and other critical tasks cannot be carried out effectively. When the number of users increases beyond a point, however, coordination becomes difficult and cooperation tends to break down, making the task of forest protection even more difficult. Thus, forest management appears to be most effective at intermediate group sizes. Theoretical expectations and explanations for this relationship are described in detail by Poteete and Ostrom (56).

Despite what one may expect, no significant relationships were observed between forest change and the fourth variable, leadership. Lack of this relationship may be because leadership is a quality hard to measure, and the effectiveness of leadership can vary over time, even reversing, making the measurable effectiveness of leadership difficult to pin down.

Discussion

Significant reforestation has taken place in recent years in the middle hills and Terai plains of Nepal (18, 20, 41). As in many rural environments across the world, this reforestation involves a combination of natural regeneration and tree planting, often within the same forests, and these forests may not contain the same range of species diversity when compared with undisturbed forests (37). These regenerating forests, however, have the potential to contribute significantly to conservation, soil stabilization, and carbon sequestration in addition to being of great value to local communities. Much of the observed increase in forest cover has been attributed to the rapid expansion of the community forestry program, which now covers large parts of the middle hills and an increasing proportion of the Terai plains (20). Yet concerns also have been expressed regarding the rapid expansion of this program, the top-down approach taken toward its implementation, and the heterogeneous nature of its impacts on forests and local communities (18, 20, 30). Much of this concern can be attributed to the simplistic manner in which programs of conservation and development are approached and the preference of policy planners and implementers for standardized "blueprint" plans that can be quickly extended across multiple regions, without paying attention to social, institutional, economic, or ecological variability.

Such programs of expansion, when adopted by national governments at large, at regional or national scales, have repeatedly ended in failure at grand scales. Despite post facto attempts to relate failures to the specific form of governance, problems have resulted from rapid expansion in all forms, such as the rapid exploitation of community forests in the Nepal Terai, the large-scale overharvesting of national forests in China (57), and excessive private logging contracts in Peru (28).

It appears clear that no single governance system can hope to protect all forests, in all parts of the world, all of the time. There are no panaceas. Yet, this lesson cannot be the only one we seek to learn from examinations of past change. Conservation biologists, scholars of the commons, and land-change scientists, among others, have attempted to identify factors associated with successful forest management. A range of variables has been identified through hundreds of detailed and very careful case studies, all of which can be shown to be important under particular contexts. How do we find useful ways to condense this information, and to locate the central framework that holds together this web of interconnected factors?

The approach used in this study offers one possible path. Beginning with a set of 17 factors identified by using a combination of theoretical literature, specific case studies, and field knowledge, it is possible to develop a theoretical understanding of critical variables and use them to examine associations between variables. Some of them, such as the relationships between tenure regime and forest size or between tenure regime and topography, may be specific to the context of this case study. Others, such as the relationship between monitoring, social capital, and the involvement of users in forest maintenance, may derive from a more fundamental theoretical basis in human behavior (32). Certain groupings of driving forces may be local, others regional, and still others may be found across all contexts.

We can hope to discern such patterns through large-N, comparative studies from the field, from the laboratory, and by using model systems. Studies of this kind are essential (34, 58–64) if we are to derive more complex, nuanced, yet actionable frameworks that help us plan better policies for the management of natural resources. This research studies a set of 17 potential drivers of change, and results affirm the central importance of tenure regime and local monitoring for achieving forest regrowth. In addition, this study finds that the size of the user group per unit forest is an important additional, independent explanator. The extension of such studies to larger datasets and to cover other regions may help identify factors that help explain additional aspects of forest change in these locations and others. Changes in tenure regime may be easier to achieve at a policy or national level but must be conducted by groups within certain size ranges and in conjunction with local efforts to monitor against overharvesting and sanction offenders, if they are to operate at their fullest potential. Together, these factors have the potential to direct the trajectory of forest change toward regrowth or further deterioration, and we must be careful how they are used.

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