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Forest Resources and Institutions

edited by

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Preface

In some places forests and trees are disappearing; in others, tree cover is increasing. What creates the incentives to foster and manage, or to cut and run? What creates disincentives to invest time and other resources in tree and forest management? Many governments, projects, communities, and organizations are struggling with questions about how to create the enabling conditions for improved short- and long-term local livelihoods and public services through effective management of forest areas.

In a global environment of great economic and political change, there is also growing interest within many national governments to change property rights radically. This raises a number of concerns for forests that need to be managed in larger units, than say agricultural land, if they are to produce the variety of products and environmental outputs desired by the various interested persons and groups. When is it most effective to vest the management of forests in local community members as individuals or as groups, and under what conditions will industries or government agencies manage the resource more effectively to reach production, social, and environmental goals? Throughout the 1990s, member governments sent requests to the Food and Agriculture Organization (FAO) for organizational and technical support for forest management, as well as for advice about appropriate forestry resource policies, legal frameworks, and market orientation.

In the early 1990s, FAO brought together an advisory group of specialists focused on issues of managing forests as common property. They urged FAO to strengthen the data available and its analysis. The group pointed out that there were many types of forest products and that frequently several community groups with different perceptions and rules for managing selected products were in any one forest at a given time. To understand the dynamics of forest use and management with this many variables, new tools were needed. This sentiment was echoed by FAO member countries who urged the development of a multidisciplinary and multilevel integrated database allowing comparison over time and between sites, as well as more nuance in interpretation.

The Community Forestry Unit's (CFU) Forests, Trees and People Programme (FTPP) was indeed fortunate to be able to work with Dr. Elinor Ostrom and her highly dedicated professional team at Indiana University to initiate the International Forestry Resources and Institutions (IFRI) research program. IFRI is not a questionnaire but rather a methodology and research protocol to organize information in a relational database that captures variation and interrelationships in the complex of factors that influence forest management. IFRI methods start with a forest and move out to all people who have an interest in its use and health. In Chapter 1, the methodology has been described as "multilevel, multi-country over-time study of forests and institutions that govern, manage, and use them."

FAO has found the IFRI approach to be especially cost effective. It takes less time than many research methodologies and can form a basis for addressing a number of immediate as well as long-term questions. Case studies without common protocol have been carried out in great number. Unfortunately, since they use different questions and methods, there was great waste and need for new studies as new issues arose. These scattered studies offered no way to compare contrasting situations even in the same region. When studies had full information about a small community, they often lacked data on the market or the policy context in which the community lived. Some studies were rich in data about the health of the forest but gave no information about existing forest institutions, use, and management. A study that shows that forest areas are degraded without incorporating the other relevant factors is impossible to use in making wise policy changes. IFRI has information to address all these research weaknesses.

IFRI information is also useful when new questions arise. For example, in Uganda when researchers were asked how to incorporate demographic and population issues into training materials on forest management planning, they were able to quickly provide especially rich information by overlaying demographic data on previously collected IFRI data. IFRI works with the philosophy that IFRI centers are based in the countries themselves and reports of findings are made to the communities, to field personnel, and to host country policymakers and the data is left in the country. IFRI does not extract research and run.

In this Working Paper the authors have drawn from their data to look at specific research hypotheses. The purposes of the original studies vary. Chapter 7 is built on researchers working as partners with Yuracare people to document their historical territory and its current usage. This issue is of great concern to the Yuracare, as the Bolivian government is demarcating land areas and wishes to be able to demonstrate their claims as well as have a basis for developing management plans. . . . Some studies have benefitted project planners and management by offering a better understanding of local use and rules as well as technical knowledge for the planning phase and over time monitoring the effects of project activity on the people as well as on the trees. Other studies have been made in order to inform government policy. The fact that this is also an international network of researchers with centers in Uganda, Bolivia, Nepal, Senegal, and other countries means that there is a support group with which researchers may discuss questions and a bigger database from which to establish hypotheses and develop queries.

The FAO wishes to thank the advisory committee for stimulating this process and all those community members, field staff, and donors who have invested in the development of this new and exciting approach. . . . A very special thanks goes to the researchers and the training and backstopping team at Indiana and at the other centers who have dedicated so much time and effort in assuring a very high quality research to better understanding the relation between people and the forests on which they depend.

Other documents related to community-based forest and tree management

The Community Forestry Unit (CFU) and the Forests, Trees and People Programme (FTPP) have developed a series of documents supporting the understanding of local forest and tree management and focusing on three aspects: tenure, institutional and legal analysis, and communal management. It is intended that these documents will be relevant to policymakers as well as practitioners in forestry programmes. The entire set of documents will be useful to universities and training centres. They are available at the Community Forestry Unit, FAO, Viale delle Terme di Caracalla, Rome 00100, Italy.

Tenure

A concept paper examines and clarifies the issues of tenure related to community forestry (Community Forestry Note 5, Community forestry: rapid appraisal of tree and land tenure, 1989). A field manual presents rapid appraisal tools for field use (Community Forestry Field Manual 4, Tree and land tenure: rapid appraisal tools, 1994). A case study from Nepal adapts and illustrates the use of the methodology to obtain tenure information for project management (Community Forestry Case Study 9, Tree and land tenure in the Eastern Terai, Nepal. A case study from the Siraha and Saptari Districts, Nepal, 1993). A case study from Madagascar illustrates the use of the field manual in policy analysis (Community Forestry Case Study 10, Tree and land tenure: using rapid appraisal to study natural resource management. A case study from Anivorano, Madagascar, 1995).

Institutional and legal analysis

A concept paper analyzes elements for understanding rules followed by stakeholding groups related to attributes of the tree resource and to incentives or disincentives for community members to expand or to manage existing tree and woodland resources (Community Forestry Note 10, A framework for analyzing institutional incentives in community forestry). A field manual applies these concepts to field conditions for increasing successful planning, implementation, and evaluation of forestry activities (Community Forestry Field Manual 7, Crafting institutional arrangements for community forestry, 1997). A working paper is being developed that analyzes the legal environments in which local forest management takes place and in what ways these often vulnerable systems can be supported through laws and regulations (to be published in 1998).

Communal management

This group of publications starts with an analysis of relevant literature from Latin America, Asia, and Sahelian African (Community Forestry Note 11, Common forest resource management: annotated bibliography of Asia, Africa and Latin America, 1993). This publication raised issues confirming that literature from the various sites in different or even the same regions was not comparable as consistent data had not been collected from site to site. The various articles and research protocol for the International Forestry Resources and Institutions (IFRI) was partially in response to this issue. This working paper, *Forest Resources and Institutions,* illustrates the crucial research questions IFRI can address, while seeking to stimulate greater interest in the IFRI approach and the work of its researchers.

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Acknowledgments

Clark Gibson, Margaret A. McKean, and Elinor Ostrom (Chapter 1): We wish to thank the Forests, Trees and People Programme at the Food and Agriculture Organization of the United Nations for their consistent support since the initiation of the International Forestry Resources and Institutions (IFRI) research program. The entire program would have been inconceivable but for their consistent support throughout the years. We wish to particularly thank Marilyn Hoskins, Krister Andersson, Hivy Ortiz, and Katherine Warner. We also wish to thank the Ford Foundation, the MacArthur Foundation, and the National Science Foundation for their support of individual projects within this broad research program. We also thank the colleagues and students for the hard work and thoughtful criticisms they have contributed to the IFRI research program over the years. Special thanks also to Patty Dalecki for her invaluable skills and effort in the editing and preparation of this volume.

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Clark Gibson is Assistant Professor of Political Science at Indiana University, and a Research Associate with the university's Center for the Study of Institutions, Population, and Environmental Change (CIPEC). A large portion of his research explores the institutions and politics of natural resources, especially forest and wildlife resources in Africa and Latin America, at both local and national levels. His work has appeared in journals such as *Human Ecology, Comparative Politics*, and *World Development.* His forthcoming book *Politicians and Poachers: The Political Economy of Wildlife Policy in Africa* (Cambridge University Press) examines the politics of wildlife management at multiple levels in Zambia, Kenya, and Zimbabwe.

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Margaret A. McKean received her Ph.D. from the University of California at Berkeley. She is a faculty member in the Department of Political Science at Duke University, where she teaches environmental politics and policy and Japanese politics. In the last decade, she has been working on the evolution of common property rights and on politics as a struggle over the production of public goods, in Japan and elsewhere. She is currently completing a manuscript on the management of common-pool goods and public goods in conditions of unusual scarcity in Japan. She served as president of the International Association for the Study of Common Property in 1995-1996.

Elinor Ostrom is Co-director of the Workshop in Political Theory and Policy Analysis and the Arthur F. Bentley Professor of Political Science at Indiana University, Bloomington. She is the author of *Governing the Commons* (1990) and *Crafting Institutions for Self-Governing Irrigation Systems* (1992); co-author with Larry Schroeder and Susan Wynne of *Institutional Incentives and Sustainable Development* (1993); and co-author with Roy Gardner and James Walker of *Rules, Games, and Common-Pool Resources* (1994).

Charles M. Schweik is a Ph.D. candidate in Public Policy at Indiana University. He has a master's degree in Public Administration from Syracuse University and an undergraduate degree in Computer Science. His dissertation, entitled "The Spatial and Temporal Analysis of Forest Resources and Institutions," relates human incentive structures and human activities to forest condition measures collected both in the field and through temporal sets of Landsat multispectral satellite images. Results of his recent research appear in *Mountain Research and Development* and *The Employee Responsibilities and Rights Journal.*

George Varughese is a Ph.D. candidate in Public Policy at Indiana University. He has a master's degree in Business Administration and an undergraduate degree in Life Sciences. He is currently researching the organization of collective action for the governance and management of forest resources in Nepal from an institutional analysis perspective. He is also interested in the institutional design of partnerships between local communities and government officials for the governance and management of natural resources. He has recently co-edited *People and Participation in Sustainable Development: Understanding the Dynamics of Natural Resource Systems* with Ganesh Shivakoti, Elinor Ostrom, Ashutosh Shukla, and Ganesh Thapa.

Mary Beth Wertime served as the International Forestry Resources and Institutions (IFRI) research program coordinator and a research associate at the Workshop in Political Theory and Policy Analysis until 1996. She has a master's degree in Public Administration from American University. She has worked in Cameroon and Mali on agro-forestry program planning and evaluation, and in Ghana, the Ivory Coast, and countries in Latin America over the past 15 years.

Acronyms and Abbreviations

CBS	Central Bureau of Statistics
CENR	Committee on Environment and Natural Resources
CERES	Center for the Study of Economic and Social Reality
CGIAR	Consultative Group on International Agricultural Research
CIPEC	Center for the Study of Institutions, Population, and Environmental Change
CRC	Collaborating research center
DBH	Diameter at breast height
DFO	District forest office
FTPP	Forests, Trees and People Programme
GIS	Geographic information system
GPS	Global positioning system
IAAS	Institute of Agriculture and Animal Science
IAD	Institutional analysis and development
IFRI	International Forestry Resources and Institutions
IRR	Incident rate ratio
MLE	Maximum likelihood estimation
NSF	National Science Foundation
NAS	National Academy of Sciences
NEAP	National Environmental Action Plan
NGO	Nongovernmental organization
OLS	Ordinary least squares
PRA	Participatory rural appraisal
RC	Residence council
UFRIC	Uganda Forestry Resources and Institutions Center
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VDC	Village development committee

Chapter 1

Explaining Deforestation: The Role of Local Institutions

Clark Gibson, Margaret A. McKean, and Elinor Ostrom

Introduction

Governments, citizens, and scientists are increasingly concerned about the role of forests in global environmental change. Evidence is mounting from multiple studies that humans at an aggregate level are exploiting forests at unsustainable rates in tropical regions.[1] While some deforestation can be attributed to rational and sustainable transfers of land to agricultural and other valuable uses, unplanned deforestation can generate significant negative externalities: loss of biodiversity, elevated risk of erosion, floods and lowered water tables, and increased release of carbon into the atmosphere associated with global climate change. More importantly, deforestation can decrease the welfare of forest users by eliminating habitat for game species, altering local climates and watersheds, and destroying critical stocks of fuel, fodder, food, and building materials.

While aggregate levels of deforestation are relatively well-known, less agreement exists among forest managers, policymakers, and scholars about the underlying and proximate causes of these increases.[2] The most frequently mentioned causes of deforestation include:

- population growth (Rudel, 1994);
- population density (Burgess, 1992);
- affluence (Ehrlich and Ehrlich, 1991; Rudel, 1994);
- technology (Ehrlich and Ehrlich, 1991);
- national debt (Kahn and McDonald, 1994);
- commercial logging (Capistrano, 1994);
- government policy (Repetto and Gillis, 1988; World Bank, 1992);

[1] *In contrast, the area and volume of forest resources are growing in most temperate regions.*
[2] *For a brief overview of the competing explanations given for deforestation see Turner (1995).*

- forest accessibility (Kummer, 1992); and
- political stability (Shafik, 1994).

Such disagreement about the most important factors means either that there are multiple processes at work and/or that significant knowledge gaps exist about these processes. Even when agreement has been reached on the importance of a certain factor, researchers have disagreed about its effect. For example, while some researchers argue that population growth is a major cause of deforestation, Caldwell (1984) suggests there is no linear relationship between population pressures and land degradation. Bilsborrow and DeLargy (1991), as well as Wolman (1993), assert that solid empirical evidence about the impact of population pressure is almost nonexistent. In fact, Blaikie and Brookfield (1987) report that land degradation occurs in areas with both increasing and decreasing population pressure, and Allen and Barnes (1985) find no relationship between the population and deforestation. An important study by Tiffen, Mortimore, and Gichuki (1994) demonstrates the impact of a five-fold increase in population in the Machakos District of Kenya between 1930 and 1990. They provide substantial evidence that increased labor availability in the locality—when combined with market opportunities, technological knowledge, and appropriate institutions—has led to sustainable resource practices, including the planting and husbandry of more, rather than fewer, trees.[3] And Varughese (this volume) finds no direct link between population and deforestation in a comparison of 18 communities in the Middle Hills of Nepal.

Similarly complex and multidirectional results are reported for other variables asserted to be causes of deforestation, including:

- individual wealth (Shafik, 1994);
- national debt (Capistrano, 1994);
- forest accessibility (Agrawal, 1995; Schweik, this volume); and
- commercial logging (Burgess, 1992; Capistrano, 1994).

Contributing to such contradictory findings is the dearth of forestry data at the national, regional, and local levels; the lack of time-series data; and the disparate definitions and measurements employed in studies of deforestation.

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[3] *What is important about the Tiffen, Mortimore, and Gichuki study is that it demonstrates the variability of responses to population changes in different localities. It challenges the presumption that a population increase at a local level will harm the ecological system at the local level. It does not address the question of population increases at a global scale (see Holling, 1994, for an overview of ecological research showing diverse responses at multiple scales to population increases), nor does it address the issues regarding secondary forests that may result from human efforts to restore areas where primary forests previously stood.*

Additionally, most analyses of forest exploitation lack linkages to the local level, despite a growing awareness among scholars and practitioners that the actions of local people greatly determine the success or failure of natural resource management schemes.[4] Because the debate about the causes of deforestation and other environmental harms has been largely confined to macroanalyses, it has failed "to benefit from the wealth of data generated at the micro level—data which provide rich information on the social and economic factors that mediate the relation between population and the environment" (Arizpe, Stone, and Major, 1994: 3).

And yet the role of people at the local level is crucial. National governments rarely possess enough personnel or money to enforce their laws adequately, prompting many officials to consider decentralizing authority over forest resources. It is becoming increasingly clear that local communities both filter and ignore the central government's rules. Importantly, they also add their own rules, generating local institutions—rules in use—and patterns of activity that can diverge widely from legislators' and bureaucrats' expectations. Because local communities live with forests, are primary users of forest products, and create rules that significantly affect forest condition, their inclusion in forestry management schemes is now considered essential by many researchers and policymakers (Arnold, 1992).

The authors in this volume seek to understand the complex interactions between local communities and their forests. To do so, they depart significantly from conventional national-level analyses and offer groundbreaking efforts to identify the relationship between forest conditions, individuals, and institutions at a local level. The presumption that guides the authors is that institutions at the local level—together with the incentives and behaviors they generate—lay at the heart of explanations of forest use and condition.

Local institutions can modify the effect of factors thought to be the driving forces of deforestation. Rare is the market, technological, demographic, or political factor that affects individuals without first being filtered by local institutions. Given certain institutional arrangements, individuals may forgo the use of a resource if it is not culturally acceptable (see Schweik). Individuals may ignore central government rules that contradict their daily patterns of resource use (see Banana and Gombya-Ssembajjwe) or ask the central government for help in protecting their resources (see Agrawal and Varughese). Individuals may construct rules to prevent the immediate commodification of their forest resource (see Agrawal, Becker and Leon,

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[4] *FAO, 1990; Ostrom, 1990; Hecht and Cockburn, 1990; Marks, 1984; Blockhus et al., 1992; Poffenberger, 1990; Bromley et al., 1992; McCay and Acheson, 1987; Ascher, 1995; Gibson and Marks, 1995. Studies of local communities and forest use do exist (for example, see Atran, 1995), but these are generally single-case studies.*

and Varughese) or they may allow the resource to be put on the market quickly (see Becker and Gibson). Since local institutions guide the daily consumption of natural resources, it is appropriate to keep them at the center of analyses concerning forest use.

Any analysis of how local institutions affect forest conditions necessarily crosses the neat boundaries of academic disciplines. Evaluating the condition of a forest requires employing the concepts and measurement techniques of biologists and ecologists. Understanding local behavior needs insights from anthropology and sociology. Examining the creation and enforcement of rules needs the input of political scientists and estimating the impact of a forest on household budgets must borrow from the economists' toolbox. The authors of the empirical studies found in this volume invest substantial effort to weave together the natural and social sciences to create more comprehensive explanations of the people-forest nexus. Further, all of the cases explicitly use the methods of the International Forestry Resources and Institutions (IFRI) research program, which not only employs a multidisciplinary approach but allows for comparison across time and space as well (see Appendix I to this volume).

Because the authors in this volume move away from simple, national-level studies of forests and towards more comprehensive accounts of forests and communities at the local level, their studies offer policymakers a more sophisticated view of forest management from which to derive policy options. The cases in this volume demonstrate that forests should not be considered as the source of only one commodity, wood; nor should users of the forest be clumped together as one group. Rather, these studies underscore how forests are associated with *multiple products* (e.g., wood for construction and/or fuel, wildlife, water, leaves, fruits, fodder, seeds, straw, shade, fertile soil, stones, etc.) and *multiple user groups* (defined by property rights, product, location, citizenship, religion, caste, ethnicity, technology, income, access). The variation of local institutions discovered by the authors also discourages the view that template forest policies are likely to work when imposed on a country as a whole. The diversity of conditions, rules, and outcomes presented in this volume's chapters, therefore, equips policymakers with an appreciation for the complexity of forestry resources as well as examples of management successes and failures that should assist in the construction of the most appropriate roles to be played by local, regional, and national authorities.

Forests, goods, rights, and owners

Clarifying the differences and similarities between types of goods, property rights, and owners is an essential first step toward an understanding of the interaction between people and forests. McKean explores these concepts in Chapter 2, noting that the differences between public and private types of goods, rights, and owners are more than semantic. The differences can have critical effects on the distribution of a forest's benefits and, ultimately, on the overall condition of the forests. To misjudge the types of goods involved with a resource system can lead to the design of inappropriate property-rights arrangements, and these can in turn create the incentive for grievous depletion rather than sustainable use.

As economists have long defined these things, property rights to resources are not the resources themselves but are human institutions, sets of mutually recognized claims and decision-making powers over those resources. Private property rights are those that are clearly specified (not vague), secure (not subject to whimsical confiscation), and exclusive to the owner of the rights. Rights that are vague, tenuous, or nonexclusive are not fully private. Private property arrangements win praise and admiration, appropriately, because they can encourage protection and investment in the goods to which they attach. Of course, they cannot do this—perhaps nothing can—in an atmosphere of chaos, insecurity, and short time horizons, and we would be wrong to blame the property-rights institutions when the real problem is overwhelming uncertainty.

McKean argues that much of the theoretical foundation underpinning the debates over property rights assumes that there are only two kinds of goods: public goods and private goods. For several decades now, political-economists have agreed that the two crucial dimensions we should use to classify goods are (1) the ease with which potential users can be excluded from access to the good (the "excludability" of the good) and (2) whether using a portion of the good shrinks the supply that remains (the "subtractability" or "rivalness" of a good). Pure public goods are nonexcludable and nonsubtractable, and private goods are both excludable and subtractable. The dichotomy of pure public goods and private goods has become the focus of discussion about types of goods ever since, and consequently many have overlooked the other two types of goods that are created by this two-by-two typology: Club goods are excludable but nonsubtractable, and common-pool goods are difficult to exclude but subtractable. Little harm has been done by ignoring club goods, because they are easy to produce (because they are excludable) and undepletable (because they are nonsubtractable). However, ignoring common-pool goods, which are difficult to produce and easy to deplete, is tragic indeed. It turns out that most environmental and natural resources that we care about are common-pool goods. They are as subtractable as private goods, but because it is difficult to control or restrict access to them (the excludability dimension), it is very difficult to restrict the rate at which they are consumed. Thus, we arrive at a recognition of environmental crisis rather underequipped and ill-accustomed to thinking about the crucial features of environmental resources. Because we have become accustomed to thinking in terms of only public goods and private goods, when we recognize that environmental resources are subtractable we begin to think of them as private goods.

If forests were like farms, producing wood as farms grow tomatoes or flax, then viewing them as private goods and creating individual private property rights in forests might be sensible. But even monoculture tree farms are frequently complex ecosystems of varied and interdependent species producing multiple products. And nonmonoculture forests are even more complex, generating goods that range from fallen leaves to berries to kindling to timber, and their resilience as productive systems requires that complexity. They also provide environmental services beyond the forest, in terms of erosion control, flood control, conservation of water, cleaning of air and water, and stabilization of local climate. The size of many forests, and the inevitable complications involved in monitoring the use of the forest and balancing one use against another, make exclusion or restrictions on access intrinsically problematic. Thus, McKean asserts that it is appropriate to think of forests as a complex of many commodities with attributes of both common-pool and public goods.

The definition of private property rights has to do with the clarity, security, and exclusivity of the right, and does not actually include any stipulation that they be vested only in single individuals. Although larger entities and groups of individuals may theoretically hold private property rights—and do in actual fact as well (e.g., business partnerships and joint-stock corporations)—much discussion forgets this. As a result, campaigns to create private property rights tend to consist of transferring ownership from larger entities and groups to individuals. In some instances, these interventions may destroy the property-rights arrangements that they should want most to create. Most privatization campaigns would ignore or even oppose the assertion that there might be conditions when it is more desirable for clear, specific, secure, and exclusive rights to be vested in a group rather than in single individuals, but McKean outlines conditions in which group rights may make more sense.

It is widely agreed that private property rights are the appropriate institution to create for commodities that are subtractable and from which it is easy to exclude others from benefits. Thus, if one thinks of natural resource systems as potentially private goods, one will advocate creating private property rights for those resources. And if one's notion of private property rights requires vesting all such rights in individuals, then one will fail to consider the possibility of vesting rights in groups or communities when that might be appropriate. McKean argues that natural resource systems that are really combinations of public and common-pool goods can have as many as four attributes that make vesting property rights in groups more efficient than vesting those rights either in a single individual or trying to parcel the resource into individually titled patches.

First, some resources are simply indivisible, and some resource systems like forests contain or produce useful items that are themselves fugitive or mobile resources. Second, on some large resource systems, particularly in arid regions, there is great uncertainty in the location from year to year of the most productive zones. Third, on resource systems with congested and competing uses and high population pressure, coordination among users is essential to cope with externalities. Fourth, group ownership and thus group enforcement of rules can be an efficient way to cope with the costs of monitoring otherwise porous boundaries and enforcing restraints on use within those boundaries. In many resource systems including forests, more than one condition, or even all four conditions, may pertain. Thus, forests make good candidates for common-property regimes: or vesting clear, specific, secure, exclusive rights to managing a resource in nearby communities.

The contributions in this volume address a variety of property-rights arrangements, and take into consideration how the institutions that surround these arrangements provide incentives for local residents to use their forests. These property-rights arrangements often have critical influences over the condition of forests.

IFRI research program

The empirical chapters following McKean's theoretical exploration accept the challenge that our understanding of forests relies on our understanding of how people at the local level interact with forest resources. In their quest for untangling these complex relationships, they draw upon the design, principles, and hypotheses of the International Forestry Resources and Institutions (IFRI) research program. The IFRI research program is a multilevel, multicountry, over-time study of forests and the institutions that govern, manage, and use them.

To help explain deforestation and loss of biodiversity, the IFRI research program draws on the Institutional Analysis and Development (IAD) framework developed and used by colleagues associated with the Workshop in Political Theory and Policy Analysis at Indiana University over several decades (Kiser and Ostrom, 1982; Ostrom, 1986; Oakerson, 1992; Ostrom, Gardner, and Walker, 1994). The IAD framework has been used to study how institutions affect human incentives and behavior as these impact on urban services in metropolitan areas, the provision and production of infrastructure (such as roads and irrigation systems), and the governance and management of natural resource systems. At the core of the IAD framework are individuals who hold different positions (e.g., members of a local forest user group; forest officials; landowners; elected local, regional, and/or national officials) who must decide upon actions (e.g., what to plant, protect, harvest, monitor, or sanction) that cumulatively affect outcomes in the world (e.g., forest conditions, the distribution of a forest's benefits and costs). To simplify representation, the complex set of incentives and resulting behavior is initially represented in Figure 1.1 as a single box.

This "box," like all of the other boxes in Figure 1.1, can be opened and contains a nested set of other conceptual boxes within it.

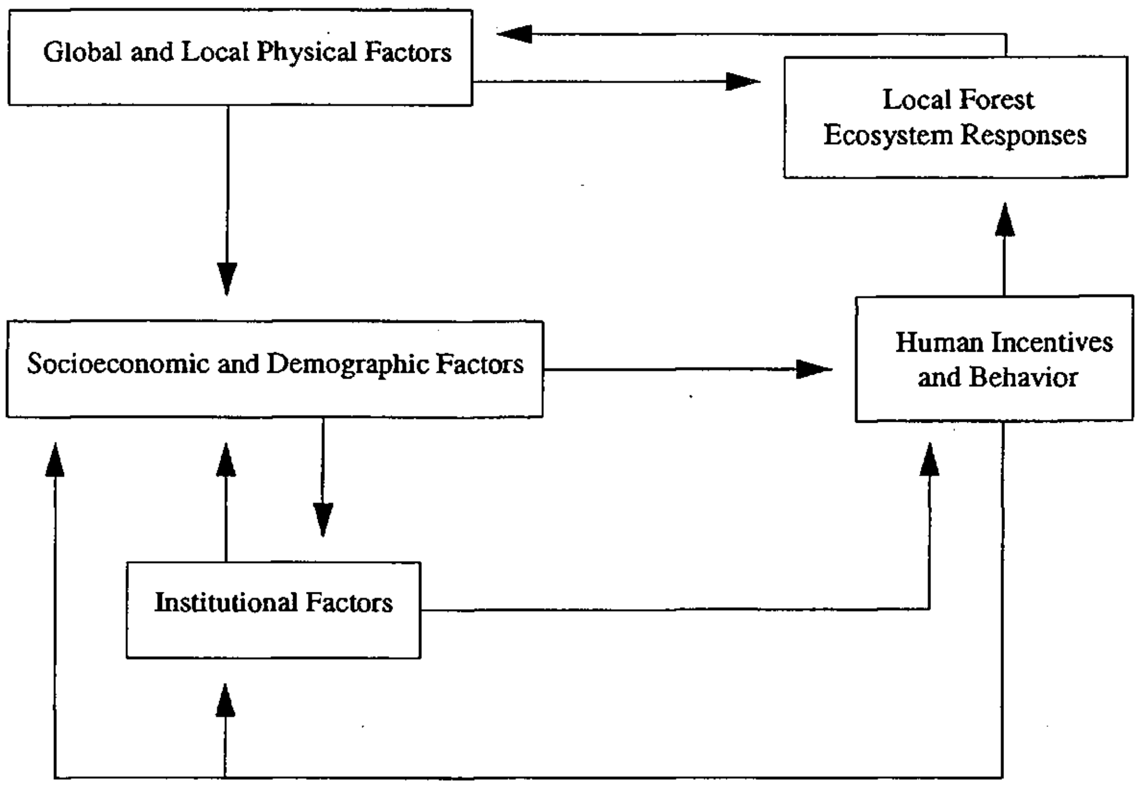

Figure 1.1: The IAD framework relating multiple factors affecting local ecosystems

In a dynamic setting, human behavior impacts on local ecologies that are also affected by (and affect) global and local physical factors. Human incentives and behavior are affected by socioeconomic and demographic factors as well as institutional factors. Each of the factors on the left-hand side of Figure 1.1 unpacks into a large set of variables. For example, unpacking the institutional factors that may affect human incentives and behavior across a large number of diverse settings includes variables at multiple levels. At a micro level, these would include, but not be limited to, such variables as:

- Specific rules-in-use for each parcel of land (or forest product) in a local ecology that differs in regard to who can harvest, when and how, and how much harvesting of different products is authorized or forbidden.
- What types of afforestation or other enhancement or protection activities are encouraged and by what means.

- What types of subsidies are provided related to the inputs or outputs of a local economy.
- How forest use and investment practices are monitored and sanctioned.
- The level of common understanding of what rules are used, monitored, and enforced.
- Whether forest users are organized and what such organization means in terms of individual incentives.
- What representatives of local, regional, or national government are involved in local activities.

At a macrolevel, these would include, but not be limited to, such variables as:

- National legislation authorizing diverse types of forests and parks in a country and the restrictions or subsidies involved in the use and administration of each type of forest.
- Types of private and/or communal land and tree tenure authorized.
- The personnel rules of national, regional, and local agencies affecting recruitment, retention, promotion, and discipline of public officials.
- Taxation laws on land, extraction rates, and corporate profits.
- The availability of courts to resolve disputes over land and/or tree tenure, contracts related to concessions, and disciplinary actions within public agencies.

Systematic information about institutional variables at a micro level are not available in any existing data set, nor are most relevant macroinstitutional variables.

One advantage of a simple framework is that a large number of nested variables can be included. And, given the complexity of the forest-local community nexus, such complexity was a given. Workshop colleagues sought input from a wide range of international scholars, including biologists, ecologists, resource economists, foresters, anthropologists, sociologists, demographers, lawyers, geographers, and political scientists. Their input was even more deeply embedded after early field testing occurred in Bolivia, Nepal, and Uganda. Thus, researchers from a variety of disciplines contributed invaluable advice about the factors that may help explain how humans impact forest condition and biodiversity. Given these many and interrelated factors, Workshop colleagues also employed a relational database to record the information gleaned by the IFRI protocols and to allow the testing of a nearly unlimited number of specific hypotheses.

IFRI researchers have concentrated first on the design of ten research protocols and careful field methods for collecting valid and reliable information about micro-level institutional, socioeconomic and demographic, and local physical factors that affect human incentives and behavior, and the impact of this behavior on local forest ecologies.[5] It is the first research program to our knowledge that combines systematic forest mensuration techniques for a sample of 1, 3, and 10-meter radius forest plots for each forest in sites where data is also systematically collected about local institutions and socioeconomic and demographic variables.

In the early stages of this research program, IFRI colleagues are analyzing a small number of cases from the initial countries where research has been conducted—Bolivia, Ecuador, India, Nepal, Uganda, and the United States. The analyses contained in this volume, for example, range from a focus on a single case study to as many as 18 cases. All of the individual studies, however, have utilized the same research protocols. Thus, as the number of studies within each country grows, it will be possible to analyze results from an ever larger number of sites. Further, IFRI researchers intend to revisit sites on a regular basis to investigate more precisely the dynamics of how local institutional changes impact on the actions of forest users and officials as well as the results of these actions on forests. Thus, the IFRI research program provides a unique opportunity to undertake systematic, micro-level, comparative studies of institutions and their impact on rates of deforestation over time.

This volume represents our initial effort to report on studies conducted in Bolivia, Ecuador, India, Nepal, and Uganda based on a common framework and using the same research protocols. Since the IFRI research program has just entered its operational phase, we hope this is the first of a growing series of publications helping policymakers, forest users, and scholars understand the microprocesses at work under the macrovariables that have been the focus of recent attention.

Empirical chapters

The empirical studies in this volume seek to fill at least two critical gaps in current forestry research. The first is the lack of comparable micro-level studies. The second is the shortage of studies that address the pivotal influence of local-level institutions on forest use and condition.

[5] *Now that the design of the micro-level studies has been completed, we are starting to design a macrolevel study using the same framework but including variables characterizing national-level entities.*

Why micro and comparative analyses are important:

Variation at local levels. Country-level data on rates of deforestation do little to help policymakers and scholars unravel the web of the causes of forest use. For example, while Uganda and Nepal have the same rate of deforestation at the national level, around 1 percent, these deforestation rates vary significantly within each country over space and time (FAO, 1993). And yet for forestry policy to be effective, an understanding of the causes of such dynamic and spatial variation within a country is critical. The empirical studies in this volume clearly demonstrate the need for scholars and policymakers to appreciate such local-level variation.

In Chapter 3, Agrawal investigates how local-level variation within the Indian *van panchayat* (forest council) system of community forestry leads to substantially different outcomes for the management of forest resources. Agrawal begins his analysis by reviewing the legislation that undergirds the van panchayat system. In response to widespread protest to the confiscation of lands by the colonial government, the British passed the 1931 Van Panchayat Act, which allowed village communities to create van panchayats to control forested areas previously administered by state revenue officials. While the Act includes the broad outlines of the panchayats' powers, local factors still generate the pattern of a panchayat's day-to-day operations.

Agrawal demonstrates that these local factors help to explain why not all of the van panchayats have managed their forest resources successfully. Comparing five van panchayats from the same region (Almora District), operating within the same ecological and administrative areas, Agrawal finds that the councils range widely in terms of their size, organization, age, and resource endowments. Evaluating how these characteristics affect forest condition, Agrawal argues against those who would assert that either per capita income or the age of van panchayats are the major factors that account for the success of local councils in managing their forest resources. Rather, Agrawal indicates that the size of the van panchayat is an ignored but important factor that affects its performance. Very small van panchayats are disadvantaged, Agrawal argues, in their efforts to generate sufficient human and other resources to monitor and enforce local rules. Moderate-sized van panchayats are able to generate greater amounts of monetary and voluntary contributions in their efforts to monitor the use of their forest, which are under constant threat of exploitation by locals and outsiders. These findings challenge those scholars and practitioners captured by an invariant "smaller is better" view. Rather, Agrawal indicates that somewhat larger organizations can have great advantages in managing forest resources at the local level. Additional studies of van panchayats are planned that will enable

Agrawal to examine a broader array of these local institutions so that the possibility of a curvilinear relationship between size of forest organization and capabilities to monitor and enforce local rules can be explored.

Banana and Gombya-Ssembajjwe's analysis of forests in Uganda (Chapter 4) further underscores the diversity of outcomes at the local level. In their examination of five forests located in four different ecological zones, Banana and Gombya-Ssembajjwe discover that the level of human consumptive activity differs widely, and has a dramatic impact on the physical condition of the forests. Three forests (Mbale, Lwamunda, and Bukaleba) show signs of heavy use in the forms of illegal commercial logging activities and livestock grazing; over 70 percent of the 90 sample plots had evidence of illegal utilization. Two other forests (Namungo and Echuya), however, showed significantly less disturbance, despite the fact that they, too, contain valuable commodities such as commercial tree species and grazing areas.

Discounting environmental and biological factors as explanations for this variation, Banana and Gombya-Ssembajjwe then consider social explanations. They indicate that most forested lands in Uganda are state property, thus offering little incentive for locals to constrain their consumption of forest products. Colonial and post-colonial regimes vested forested lands within the central government, disregarding indigenous property rights or management schemes. Without a stake in the tenure of the resource, the authors argue, local villagers have the incentive to consume forest commodities opportunistically. Thus, the degradation of Uganda's forested lands should be expected.

But Banana and Gombya-Ssembajjwe assert that this general lack of tenure at the local level does not explain the variation of forest condition found in their five cases. The authors turn to the level of enforcement for each forest to account for these differences. Mbale, Lwamunda, and Bukaleba Forests are all state-owned forest reserves. Each forest is monitored only by Uganda's Forest Department, which possesses relatively few staff to fulfill their protective function. Further, Department staff have few incentives to patrol frequently, since the benefits resulting from their employment are not closely tied to their enforcement of the law. During the past several decades, the Forest Department has not been able to enforce its rules in a uniform manner. Thus, little common understanding exists of what rules might actually be in practice. The Echuya and Namungo Forests, on the other hand, both have had a much greater stability in the rules that are enforced and a much greater level of monitoring and enforcement. While Echuya is a government reserve, the Forest Department has augmented its monitoring capabilities by using the help of an Abayanda (pygmy) community that resides in the forest. The Abayanda benefit from access to forest products in return for their monitoring duties. Namungo's Forest is a privately-owned woodland for which a family hires its own guards. Those villagers who live near to Namungo's Forest also help monitor its use since the family allows villagers their traditional rights to extract certain levels of firewood, poles, medicines, fruit, fodder, and other forest products. Thus, Banana and Gombya-Ssembajjwe demonstrate that property rights and their enforcement help to explain the variation of forest conditions found in their site.

Schweik's analysis in Chapter 5 delves even more deeply into issues regarding the spatial variation of forest condition. Schweik seeks to account for the spatial variation of the Sal tree, *Shorea robusta*, that villagers living in the Chitwan District of southern Nepal find particularly valuable for fuelwood, tool-making, and construction. Using a sophisticated combination of tools including Global Positioning Satellite (GPS) equipment, Geographic Information System (GIS) software, the IFRI research protocols, and a maximum likelihood regression model, Schweik attempts to capture the influence of the most important factors that affect the growth pattern of *Shorea robusta*.

To establish the human and nonhuman impedances to the growth of *Shorea robusta*, Schweik first gathers data from a relatively undisturbed forest to establish the unimpeded or "natural" distribution of *Shorea robusta*. In such a setting, the tree lives in clusters, generating a negative binomial distribution (as opposed to a random or uniform distribution of trees), a finding critical to the appropriate specification of his statistical model. Schweik then discusses and measures the nonhuman factors that could influence *Shorea robusta*'s distribution, including slope steepness, slope aspect, elevation, competing species growth, soil characteristics, proximity of other seed trees, animal grazing, and meteorological factors. Finally, the author attempts to capture the influence of humans on the tree's distribution by pinpointing the position of villages in relation to more than 90 sampled forest plots by using GPS and GIS technologies.

Schweik's results reveal that the distribution of *Shorea robusta* trees in the sample forest plots differs significantly from the distribution found in an undisturbed setting, i.e., it does not follow a clumped pattern. Certain nonhuman factors account for some of this pattern: steepness of slope, slope aspect, competing trees, number of extant *Shorea robusta* trees, and depth of humus layer.

Schweik also finds two location variables—the elevation and the east-west location of plots—to be significant, and he links them with human behavior at the local level. Given that *Shorea robusta* grows at elevations up to 1,200 meters, its distribution should not be affected in the area under study (extant hills do not exceed 800 meters). Schweik's results, however, show that in the study site, the number of trees increases at higher elevations. Such an outcome resonates with optimal foraging theory, which argues that individuals seek the easiest source for their resources: climbing hills to gather trees makes them more difficult to acquire, and thus fewer would be taken at higher elevations. The decrease in trees from west to east, however, is not captured by either the nonhuman factors or simple optimal foraging theory, since the pattern of exploitation should result only in a ringed pattern surrounding villages, not in a systematic decrease in trees from west to east. Schweik finds the operation of Nepal's caste system to be the most convincing explanation for the west to east decrease of *Shorea robusta*: villages in the west tend to be composed of higher caste Nepalis, who are allowed to gather wood in both their forests and neighboring forests used by lower castes. Members of eastern villages can only use their own forests, being disallowed from using the forests of the higher castes in the west. Thus, the forests of the east are used at a greater rate than those in the west. Schweik's path-breaking analysis demonstrates how human use patterns vary significantly at the micro level, leading to differences in forest condition within forested areas as small as 10 square kilometers.

Becker and Gibson's examination of the relationship between the members of the Loma Alta commune and their fog forest in Ecuador highlights how the nexus of users, property rights, and forest products may account for the variation found in a forest's condition (see Chapter 6). Their study of the *comuna* is timely: Loma Alta is one of many comunas located along the watersheds of the Chongon Colonche mountain range of western Ecuador, whose last stands of tropical forest are home to numerous endemic species—so many, in fact, that some conservationists consider the area's protection a global priority.

Unlike other national governments—and central to this study—is the fact that Ecuador recognizes the rights of some local communities to govern their local affairs. In 1936, the central government passed the Law of the Comunas, empowering 32 communities living in the coastal areas to hold land jointly and act as their own local governments. Although the land is held in common, the comuna still allocates its members distinct plots to use as they see fit. The members' rights to the land are only constrained by two rules: they must use the land, and they may not sell it. Otherwise, the plots are treated as private property, with members making capital improvements to the land, passing it on to their offspring, and renting it to other comuna members.

Becker and Gibson argue that this system of property rights directly affects the condition of the comuna's upland fog forest. In the part of the forest that has not been allocated to individuals, members and outsiders have seriously degraded the forest. Approximately 70 percent of the forest cover has been removed, and large cleared areas exist—testimony to the commercial selling of timber and the conversion of forest into pastureland. Where individuals have been allocated plots in the forest, however, it has endured far less exploitation.

Variation also exists within those plots that have been allocated to individuals. At elevations above 300 meters, some land within the forest has been cleared to establish plantations of the cash crop paja toquilla (*Carludovica palmate*). Farmers plant paja at this elevation since the tree needs the moisture that the forest at higher elevations provides.

Becker and Gibson find that the particular system of property rights within the Loma Alta comuna, the value of the forest as land for paja toquilla, and timber sales has led to a specific pattern of deforestation in the communal forest. Although many parts of the forest still display the characteristics of a relatively healthy secondary forest (having been commercially logged over the last century), the authors argue that the forest remains threatened by the possible expansion of farming activities and the lack of comuna rules regarding land use.

Becker and Leon (Chapter 7) investigate the variation that occurs in forest conditions even where used by the same ethnic group along the same river. The authors focus on the relationship between three Yuracare settlements and their adjacent riparian forest along the Rio Chapare in Bolivia. In their attempt to explore if and how these Yuracare communities might manage their forest, Becker and Leon draw on biological measures of the forests and compare them with a reference forest of the same type that has known to be relatively unused. In addition, the authors selected the three sites because they vary in their distance from the closest market and in their population.

Becker and Leon find a complex pattern of behavior and outcomes in their study. The forests do, in fact, display predictable variations along the dimensions of moisture gradient, distance to markets, and population pressure. But the authors find results that go beyond these simple causes, the most important of which is that the Yuracare are clearly managing their forested areas to increase the populations of game animals. By planting and tending to fruit trees, the Yuracare intentionally alter the forest to suit their preferences for certain food types. Becker and Leon argue that these local institutions are under threat, however, as markets increasingly penetrate the area, causing changes in Yuracare preferences in food and labor.

In Chapter 8, Varughese encounters substantial variation in both the condition of the forest and community forest management in his study of 18 cases in the Middle Hills of Nepal. Although all the communities he studied depended on between user groups and the variation over their preferred forest product critically affect how and if rules are created to manage forest resources.

Becker and Leon's study of the Yuracare challenges those in the central government of Bolivia who had thought forested areas of the Amazon were unmanaged. The Yuracare have a long history of managing their forests for particular ends. The authors find evidence of such forest institutions in the language of the Yuracare as well as in the biological condition of the forest where indigenous timber species are more conserved than commercial timber species, and fruit trees preferred by the game the Yuracare hunt are planted and nurtured.

Locally-constructed institutions are at the center of Varughese's explanation of forest condition in 18 sites in Nepal as well. In those sites where communities have crafted institutions to deal with the management of forest resources, the forest tends to be in better condition than in those sites where communities have not made, or confronted obstacles to, efforts at organizing themselves. Varughese finds that such obstacles can result from both internal or external sources. This study offers powerful evidence that research that focuses solely on population as a driver of deforestation may be far off the mark, especially if the attempt is to explain the variations that may be found at the local level.

Conclusion

By featuring variation at the local level, this volume's contributions offer two general lessons to policymakers interested in forest management. First, national- or even regional-level policy may not fit local circumstances. The studies show that within even relatively small, ecologically similar areas under the same set of national laws, numerous nonbiological factors help to explain variation in forest condition. Different user groups, systems of property rights, types of commodities taken from a forest, and extant levels of rule enforcement interact with national legislation in different ways to produce particular patterns of forest use and conditions. Thus, while each local community operates under the same national legislation, their behavior and impact on forests differs substantially. For example, Agrawal and Varughese both report that some local communities respond by hiring guards to protect their forests while others do not. Banana and Gombya-Ssembajjwe demonstrate that locals enforce national forestry legislation in some areas of Uganda while in other areas it is ignored by community members. Schweik claims that most individuals in his study area routinely flout the national law proscribing wood harvesting. Such cases reveal that forest management is intensely local, and that national legislation can be modified, ignored, or enforced by local communities to fit their circumstances.

In addition to the lessons generated by the cases' variance, they also offer common insights regarding how management schemes may be successful. One crucial factor that emerges is the importance of commonly understood rules and their enforcement. Successful enforcement at the local level is partially dependent upon individuals generally agreeing upon what rules they should follow (and, hopefully, why they have been adopted). Without this agreement, there is less incentive to comply with rules: if either local forest users or government guards monitor forest use, a lack of agreement about rules would achieve a lower level of rule compliance. Efforts to guard effectively in this case result either in the type of corruption that often occurs between government guards and local forest users (especially bribery) or very high levels of conflict. Once some common agreement is achieved, then investment in monitoring has a high return by ensuring that the temptations that face all users do not grow into consistent rule-breaking behavior. In the case from Uganda, for example, the well-understood and long-standing extension of traditional rights by a private owner to nearby residents combined with active monitoring has generated a forest in relatively good condition, especially as compared to a neighboring government forest that does not enjoy much protection from its government guards. One of the central points of Agrawal's investigation is that moderately-sized communities who agree on a general set of rules regarding forest use can better afford to share monitoring duties and thus enjoy better forest resources. Becker and Gibson find that lands that lack an agreed-upon set of rules for their use are overexploited by both locals and outsiders. These studies concur with the growing theoretical consensus that argues that without common understanding and resources sufficient to monitor and sanction rule breakers, rules restricting activities that generate high private benefits are moot, whether made and enforced by the national government or the local community.

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Chapter 2

Common Property: What Is It, What Is It Good For, and What Makes It Work?

Margaret A. McKean

For more than a decade now, I have been involved in the study of "common-property regimes" for natural resources, or what might more comfortably be described as institutional arrangements for the cooperative (shared, joint, collective) use, management, and sometimes ownership of natural resources. Given this definition, common-property regimes broadly speaking should range from communal systems of resource use among hunter gatherers to mixed systems of, for example, communal pasture with individually owned arable fields, all the way to gigantic collective farms in socialist economies and even, for that matter, to the assertion of community and other broadly shared rights to regulate the environmental consequences of individual behavior in industrial economies. However, although policymakers have "picked up" on the importance of property rights in affecting environmental outcomes, they are currently designing radical changes in property-rights arrangements in transitional economies with virtually no knowledge of the specifics of what we are learning about common-property regimes for natural resources.

"Privatization" of property rights is a global fad right now: privatization of public enterprise in capitalist countries, decentralization of control over public enterprises (that nonetheless remain publicly owned) in socialist countries, privatization of property rights in general in post-socialist countries. In the developing world (which is largely capitalist), there is also great enthusiasm for the privatization of traditional community lands and some government-owned lands. I am in basic agreement with the **objectives** of this conversion: to increase efficiency (when is wasting human effort or natural resources ever justifiable?), to enhance the incentives for investment and, most crucially in the case of environmental resources, to create the incentive for resource protection and sustainable management. But at the same time, I fear that this "privatization" is being conducted without sufficient consideration of such issues as these:

a. In whom (to how many persons, to which persons, with what distributional consequences) should property rights be vested?
b. Which rights should be transferred—full ownership with rights of transfer, or just use rights?
c. What kinds of resources should be privatized? Are all objects equally divisible? Should ecosystem boundaries matter?

Silly as it may seem, I am convinced that part of our problem is semantic: we use the same pair of adjectives, "public" and "private," as labels for three different pairs of things. We use them to distinguish between two different kinds of goods (public goods and private goods), between two different kinds of rights (public rights and private rights), and between two different kinds of bodies that may own things (public entities or governments, and private entities or individuals). Economists have for decades agreed that the privateness of a *good* is a physical given having to do with the excludability and subtractability of the good, and that these two attributes of a good are crucial to understanding what humans can and cannot do with different kinds of goods. This definition of goods, creating the four-way typology shown in Table 2.1, goes virtually unchallenged, although it is sometimes forgotten or misused as we will see below.[1] The privateness of a *right* refers to the clarity, security, and especially the exclusivity of the right: a fully private right specifies clearly what the rights-holder is entitled to do, is secure so that the holder of the right is protected from confiscation by others, and is exclusively vested in the holder of the right and definitely not in nonholders of the right. It is important to note here that the privateness of a right has to do with the right, and not the entity holding it; there is no requirement that this entity be a single individual. Finally, the privateness of a *body* has to do with its representational claims, in that a *public body* claims to represent the general population and not just one interest within that population, whereas a private body represents only itself.[2]

This confusion of the publicness and privateness of **goods** (a natural given), **rights** (an institutional invention), and **owners** of rights (entities that make different representational claims) has led to serious errors. First, we get **goods and owners** mixed up, falling very easily into the habit of thinking that public entities own and produce public goods while private entities own and produce private goods and

[1] *The nature of a good can change with technology. Thus, TV broadcasts from satellites are pure public goods when the satellite signals are unscrambled. The advent of scramblers, cable services, and purchasable descrambler boxes converts TV broadcasts into excludable and nonsubtractable goods (thus toll goods or club goods). The advent of cheap illegal descramblers converts TV broadcasts back into nearly public goods again. But at any particular technological moment, the nature of a good is indeed a given.*

[2] *This definition obviously does not include all governments. Many autocratic governments neither intend nor accomplish the representation of the general public, and would be better described as private government.*

that anything produced by government is a public good and anything produced by private parties is a private good. In fact, of course, there is no intellectual reason for this simple pairing-off. Public entities are perfectly capable of producing private goods, and private entities occasionally produce public goods (though not often intentionally). Second, we get **goods and rights** mixed up, and often attempt to create public rights in private goods and private rights in pure public goods or common-pool goods, with tragicomic effects (e.g., awarding an infinite amount of rights to an exhaustible resource, or awarding exclusive rights to resources that cannot be exclusively held). Third, we get **rights and owners** mixed up, thinking that private entities hold private (exclusive) rights and public bodies hold public rights, when in fact public rights (rights of access and use that do not include the right to exclude others from such use) are generally held by private entities because public bodies have created such rights for citizens. Similarly, public bodies hold both public rights (say, the use of an assembly hall or a courtroom that is also open to all citizens as observers) as well as private rights (say, to the use of individual legislator's offices, staff, and equipment).

Table 2.1: Type of good, by physical characteristics

	Exclusion Easy	Exclusion Difficult or Costly
Subtractable (rivalrous in consumption)	**Private goods** trees, sheep, fish, chocolate cake	**Common-pool goods** forest, pasture, fishery, any environmental sink over time
Nonsubtractable (nonrivalrous in consumption)	**Club or Toll goods** Kiwanis club, camaraderie	**Pure public goods** defense, TV broadcasts, lighthouse beams, an environmental sink at a given instant, a given level of public health, a given level of inflation

Why should we care about getting the **privateness and publicness** of **goods, rights, and owners** straight? Is this simply a theoretical issue to keep scholars busy, or are there practical implications? Not surprisingly, this chapter argues that there are serious practical consequences that make definitional clarity worthwhile. First, in examining privateness and publicness of goods we slip easily into thinking that this dyad of private goods and public goods is complete when it is not. In fact, since we know that private goods are not problematic (they get produced in just the quantities we want, and efficiently too, and they are subject neither to nonprovision nor to depletion), this dyad would lead us to conclude that all of our problems arise from pure public goods. But, we would be quite wrong; in fact, the class of pure public goods is shrinking rapidly as crowding effects turn many of them into the hybrid variety that this dyad omits, common-pool goods. The omission of common-pool goods from the public-private dyad is dangerous because it is precisely the overlooked but growing class of common-pool goods where almost all environmental resources fall. Second, in separating goods from property rights we can improve the match or fit between property rights and goods, improving our ability to provide and maintain common-pool goods. Third, if we fail to sort out the publicness and privateness of owning entities we risk falling into the simplistic and the sloppy habit of thinking that only individual persons can be private entities capable of owning private property, and overlook the possibility that groups of individuals can be private organizations whose individual members share private rights. Finally, I would argue that definitional clarity is a foundation upon which we can begin to detect the circumstances in which common-property arrangements are appropriate, desirable, and even in some situations utterly essential to sound resource management. We need definitional clarity to understand how a group of individuals might be a *private owner* that can share property rights and thus create a regime of *common property rights* for managing *common-pool goods.*

Because of the errors itemized above, the campaign to "privatize" ignores the nature of the goods or resources involved and confuses owners, rights, and goods with each other. By assuming that many of these resources are problematic "public goods" and therefore need "converting" into nonproblematic "private goods" (the only other class of goods they may recognize), the privatizers often imagine that they can change the nature of the good. Instead, of course, they should recognize the nature of the good as a given and recognize that what humans can manipulate are systems of rights and the identity of owning entities. Failing to recognize the nature of common-pool resources, privatizers too readily campaign on behalf of chopping up natural resource systems into environmentally inappropriate bits and pieces, and of awarding rights in the bits to individuals—rather than maintaining resource systems as productive wholes and awarding rights to groups of individuals (private groups of private individuals). The danger of this fuzzy thinking—collapsing goods, rights, and owners into a single blur, and imagining that private goods/rights/owners and public goods/rights/owners subsume the universe of possibilities—is that we have no adequate way to recognize or classify common-property regimes for common-pool goods, we misdiagnose the cause of our difficulties as the failure to force all goods to be private goods, we destroy functioning common-property regimes that already exist, and we fail to create them where they should be considered. The rest of this chapter concerns common-pool goods (not public goods) and the common-property regimes (systems of shared private rights owned by private entities) that have been and can still be devised to manage these resources.

Common-property regimes, used by communities to manage forests and other resources for long-term benefit, were once widespread around the globe. Some may have disappeared naturally as communities opted for other arrangements, particularly in the face of technological and economic change, but common-property regimes seem in most instances to have been legislated out of existence. This happened several different ways: where common-property regimes, however elaborate and long-lasting, had never been codified they may simply have been left out of a country's first attempt to formalize and codify property rights to the resources in question (as in Indonesia, Brazil, and most of sub-Saharan Africa). Where common-property regimes had legal recognition, there may have been in essence a land reform that transferred all such rights to particular individuals (as in English enclosure) or to the government itself, or both (as in India and Japan).

Among the many justifications usually advanced for eliminating community ownership of resources was the argument that individual or public ownership would offer enhanced efficiency in resource use and greater long-term protection of the resource. But in many instances around the world today, it is apparent that the arrangements that emerged to replace common-property regimes are ineffective in promoting sustainable resource management. Where people still live near the resource their lives depend upon, the transfer of their traditional rights into other hands does not simultaneously transfer the physical opportunity to use these resources. The people who live nearest these resources still have ample opportunity to use them, but when they lose secure property rights in the resources to others, they also lose any incentive they might have felt in the past to manage these resources for maximum long-term benefit. Now they might as well compete with each other and new users and claimants in a race to extract as much short-term benefit from the resource as possible. Thus in many instances, the transfer of property rights from traditional user groups to others eliminates incentives for monitoring and restrained use, converts owner-protectors into poachers, and thus exacerbates the resource depletion it was supposedly intended to prevent. Thus, there is renewed interest both in the lessons to be learned from successful common-property regimes of the past and present (see McKean, 1992a, 1992b; Netting, 1981; Berkes, 1992; Agrawal, 1994; Blomquist, 1992; Ostrom, 1986; and Thomson, 1992) and in the possibility of reviving community ownership or management as a practical remedy where appropriate.

This chapter begins by exploring what common property is, then itemizes some of the potential advantages of using common-property regimes to govern and manage environmental resources, and concludes with a short summary of what we already know about the attributes of successful common-property regimes.

Definitions

Common-pool resources

Before one can talk about what value there may be in common-property arrangements, it is necessary to define terms. Unfortunately, there is a long history of confusing and conflicting usage. The first task is to distinguish between types of goods. I will use "common-pool resources" to refer to goods where, as with public goods, it is costly or difficult to exclude potential users, but which are subtractable or rival in consumption (and can thus disappear), like private goods (see Table 2.1). The term "common-pool resources" therefore refers to the physical qualities of a natural resource, and not to the social institutions human beings have attached to them. I use "common property" or "common-property regime" to refer to a particular property-rights arrangement in which a group of resource users share rights and duties toward a resource. These terms therefore refer to social institutions, and not to any inherent natural or physical qualities of the resource.[3]

As Table 2.1 indicates, common-pool resources have two defining traits. First is the exclusion problem: it is costly to develop institutions to exclude potential beneficiaries from them, as is the case with public goods. Without institutional mechanisms to exclude noncontributing beneficiaries from common-pool resources, they are essentially open-access resources available to anyone and therefore unlikely to elicit investments in maintenance or protection. Second is subtractability: the resource units harvested by one individual are not available to others—they are subtractable or rivalrous in consumption, like private goods, and can thus be depleted. The subtractability of consumption means that *de facto* open-access arrangements lead quickly to resource depletion.

A **pure public good** is one whose consumption does not reduce the quantity available to others to consume; it is therefore ubiquitous, and in being nonrivalrous or nonsubtractable or joint in supply it cannot be depleted. The chief problem with pure public goods is provision—how will they get produced?—and not with depletion of whatever supply happens to materialize. But **common-pool goods** pose both challenges of provision or supply and the risk of depletion. Not only is it difficult to get them produced but it is easy to deplete the supply of whatever does get produced. Many goods once described as pure public goods (nonsubtractable in consumption) in economics textbooks—air, water, roads, bridges—really are not pure

[3] *I prefer to avoid the often-used term "common-property resources" because it conflates property (a social institution) with resources (a part of the natural world). I will also avoid using the acronym CPR in the text that follows, since that could easily stand for any of the three terms (common-property resources, common-pool resources, or common-property regimes—not to mention cardio-pulmonary resuscitation!).*

public goods at all. They are, in fact, subject to crowding and depletion. Roads and bridges may be accessible by anyone, but they really cannot hold an infinite number of people or cars, as anyone who has ever been stuck in a bad traffic jam understands quite well. And, even if use is not all simultaneous but sequential, a road or a bridge has a finite lifetime, and has only so much weight-bearing capacity before it crumbles or collapses. Air and water sinks have only so much absorptive capacity for pollution before they become seriously degraded. Since most environmental resources as well as the absorptive capacity of any environmental sink are common-pool goods over time, the task of environmental management contains both the challenges of provision and of maintenance or depletion-avoidance. Although there has been a great deal of theoretical work and experimental economics done on pure public goods, the truly problematic category, into which natural resource systems and environmental resources fall, is common-pool goods. Common-pool goods do not fulfill the pure public good requirement of nonsubtractability—they are, regrettably, depletable. Thus, there is some risk that we might extract overly optimistic lessons from theoretical and experimental work that actually concerns (nondepletable) pure public goods. Fortunately, new game-theoretic and experimental work based on common-pool goods is also being done (see Ostrom, Gardner, and Walker, 1994).

Common-property regimes

The nature of a good is an inherent physical characteristic, not susceptible to manipulation by humans. But property institutions are human inventions. The "privateness" of property rights refers to the clarity, specificity, and especially the exclusivity of the rights, and not to the identity of the rights-holder. Thus, most of the permutations and combinations of resource types, property-rights types, and rights-holders theoretically exist. Surprisingly, there is very little agreement about which of these combinations and permutations are wise or efficient. There is overwhelming consensus on perhaps only two points about the appropriate combination of property rights and goods: (1) that private goods are best held as private property and (2) that private property is an inadequate arrangement for public goods/bads (i.e., where we have positive/negative externalities). There is also consensus, though weaker, on the inefficiencies due to principal-agent problems and rent-seeking that inevitably follow from vesting ownership in any entity other than a single individual with a central nervous system. Thus, there is considerable controversy over when it improves matters (whatever the criterion for improvement that one chooses) to vest ownership in public entities or collectivities. And we are left with a gnawing problem. What kind of property-rights arrangement do we design when we know that simple individual private property is inadequate—when there are externalities and when we are concerned with pure public goods and common-pool goods? These are not problems we can ignore: human beings want public goods and common-pool goods, and deserve to have them efficiently provided, and natural resource systems on which we depend utterly are, like it or not, common-pool resources.

I argue here that, far from being quaint relics of a hunter-gatherer or medieval past, common-property regimes may be what we need to create for the management of common-pool resources, at least if we can identify the factors and conditions that lead to successful regimes. Sharing rights can help resource users get around problems of exclusion. They can patrol each other's use, and they can band together to patrol the entire resource system and protect it from invasion by persons outside of their group. Solving the exclusion problem, then, begins to solve the problems of provision and maintenance. But people can bullheadedly insist on creating fully individualized and parcelled private property rights on common-pool resources, and end up with management problems because they do not acknowledge the physical challenge of exclusion. This may well be the fate of privatization schemes inappropriately applied to common-pool resources. And people can also decide, possibly for reasons of ideology or romantic nostalgia, to create common-property regimes to govern perfectly private goods that require no coordination among persons for their management.

Oddly, the term "common property" seems to have entered the social science lexicon to refer not to any form of property at all but to its absence—nonproperty or open-access resources to which no one has defined rights or duties (Gordon, 1954; Scott, 1955; Demsetz, 1967; Alchian and Demsetz, 1973). The inefficiencies and resource exhaustion to which open-access arrangements are prone are well known.[4] Open access is an acceptable method for resource management only when we need not manage resources at all: when demand is too low to make the effort worthwhile. In a common-property arrangement, on the other hand, a particular group of individuals share rights to a resource. Thus, there is property rather than nonproperty (rights rather than the absence of rights), and these are common not to all but to a specified group of users. Thus, common property is not access open to all but access limited to a specific group of users who hold their rights in common (Runge, 1981, 1984, 1992; Bromley and Cernea, 1989; Bromley et al., 1992). Indeed, when the group of individuals and the property rights they share are well defined, common property should be classified as a form of shared private property—a form of ownership that should be of great interest to anyone who believes that private property rights promote long time horizons and responsible stewardship of resources.

[4] *Garrett Hardin's (1968) classic essay on the tragedy of the commons points out the hazards of open access, without stating clearly that the problem was the lack of a property-rights or management regime (the openness of access), not the sharing of use (common use). Hardin (1994) has taken steps to rectify this oversight in more recent work that distinguishes between the unmanaged (unowned) commons subject to tragedy and the managed (owned) commons where property rights may be able to prevent misuse of the resource.*

American economists (North, 1990; North and Thomas, 1973; Demsetz, 1967; Alchian and Demsetz, 1973; Anderson and Hill, 1977; Libecap, 1989; Johnson and Libecap, 1982) have argued persuasively that property rights emerge in response to conflict over resource use and conflicting claims over resources, and that well-defined property rights help to promote more efficient use of resources and more responsible long-term care of the resource base.[5] A complete bundle of rights would include assorted rights of use (the right to use, to change the use of, all the way to the right to destroy a resource), as well as rights of alienation (e.g., transfer through bequeathing rights to heirs and/or selling rights).

Economists (Locke, 1965; De Alessi, 1980, 1982; Libecap, 1989) usually argue, in addition, that economic growth results from the creation of private property rights to the extent that they have the following four attributes: (a) they should be *clearly specified*, setting out exactly what the holder of the right is entitled to do; (b) they must be *exclusive*, vested in the holder of the right and not in nonholders of the right; (c) they must be *secure*, so the holder of the right is protected from confiscation by others and by the state alike; and (d) they should comprise an *intact* bundle of rights, so the holder of use rights also holds the right to change the way the resource is used, even to destroy it, as well as rights of alienation through sale or bequeathal (Schlager and Ostrom, 1992, 1993).[6] It is important to note here again that the definition of private property rights has to do with the *rights*, not with the nature of the entity that holds them. The privateness of private property rights does not require that they be held by individual persons. Private property rights can be vested in groups of individuals as well. All of us acknowledge that private property rights can be vested in business partnerships and joint-stock corporations. We need to understand that a common-property regime can be similar to these.

Scholars who have designed taxonomies to point out the difference between open-access arrangements (no arrangements, rules, or property rights at all) and common property usually distinguish four "types" of property: public (state-owned), private, common, and open access (Berkes et al., 1989; Feeny et al., 1990; Bromley and Cernea, 1989; and Ostrom, 1990). Although it is extremely important to

[5] *Note that this evolution is only probable, not guaranteed. Conflict over resource use can simply continue without efficiency-enhancing evolution of clearer property rights. Tai-Shuenn Yang (1987) argues that the retention of residual imperial prerogatives over all resources in China made all property rights that did evolve there merely temporary and insecure and inhibited economic growth in China for two millennia. Peter Perdue (1994) disputes this explanation, however.*

[6] *I agree with points (a), (b), and (c), but I can envision circumstances in a congested world of layered externalities in which a reconfiguration of bundles of rights might be more socially efficient. I am intrigued, for instance, with the idea of allocating use rights to wildlife to people who live near the wildlife resource, but allocating the right to destroy (and thus also to preserve) the species itself, and the genetic material that individuals in a species carry, to an international body that acts as trustee for all humans. But this is an argument for another time and place.*

recognize that common-property regimes are not open access, this four-way taxonomy unfortunately creates the regrettable impression that common property is not private property either, and does not share in the desirable attributes of private property. I think it extremely important to point out here that common property is shared private property, and should be classified wherever we put business partnerships, joint-stock corporations, and cooperatives. The property rights in a common-property regime can be very clearly specified, they are by definition exclusive to the co-owners (members of the user group), they are secure if they receive appropriate legal support from governments, and in some settings are fully alienable. Some Swiss alpine common-property regimes, some Japanese agricultural and forest common-property regimes, and all Japanese fishing cooperatives permit trading in shares (the individually parcelled rights to flow or income), and all have mechanisms by which the entire common-property user group may actually sell its assets (the shared rights to stock or capital assets of the user group or corporation) (Netting, 1981; Glaser, 1987; McKean, 1992a).

Sharing private property does have its weaknesses: all arrangements of shared private property, from firms to resource cooperatives, contain internal collective-action problems because they are comprised of more than one individual owner. Just as there can be shirking and agency problems in a firm, there can be temptations inside a common-property regime to cheat on community rules. But there are productive efficiencies to be captured through team production that may be larger than losses due to shirking, making centralized or large-scale forms of production like the firm worthwhile anyway. Similarly, there may be gains from joint management of an intact resource that can outweigh losses due to cheating (or the cost of mechanisms to deter cheating) in a common-property regime (Coase, 1937; Miller, 1993).

Advantages of common-property regimes

Once we understand the difference between goods and property rights (discussed above), we can understand common-property regimes as a way of privatizing the *rights* to goods without dividing the *goods* into pieces: in effect, privatizing rights to **flow** without privatizing or parcelling the rights to the **stock** or resource system itself. Consider, for instance, the various ways in which two people may own a typewriter. They could try to parcel the typewriter—chop it in half perhaps down the middle of the keyboard so that one can produce documents consisting mostly of "ASDFG" and the other can compose documents containing a lot of "YUIOP." But even the most rivalrous pair of aspiring typists will understand that parcelling the typewriter itself destroys most of its use value. A second scheme would be for one to own the typewriter and rent out occasional access to it to the other person (equivalent to the classic landlord-tenant relationship on the land). And a third scheme would be for them to share ownership of the typewriter itself and divide access to it into equal time-shares. They might even allow mortgaging or subletting or subsequent sale of their time-shares. In this way they share ownership of the productive stock without chopping it in half, and they parcel the flow of use units into individually owned rights (equivalent to shared private ownership, or common property). Natural resource systems have something in common with the typewriter of this example: they can be far more productive when left intact than when sliced up.

Similarly, common property offers a way of parcelling the flow of skimmable or harvestable "income" (the interest) from an interactive resource system without parcelling the principal itself. It would obviously be desirable when the resource system, like the typewriter in our example above, is most productively managed as an intact whole rather than in uncoordinated bits and pieces. Inherent in this basic characteristic of common property—the combination of individually parcelled rights to flow with shared rights to an intact stock—lies the explanation for its appearance among human institutions. Historically, we find common-property regimes in places where a resource production system gets congested (demand is too great to tolerate continuing open access nonmanagement) so property rights in resources have to be created, but some other factor makes it impossible or undesirable to parcel the resource itself (see Table 2.2).

Table 2.2: Stock and flow attributes of property-rights regimes

	Individual Property Rights	Common Property Rights	Public Property Rights
Rights to flow	parcelled	parcelled	intact
Rights to stock	parcelled	intact	intact

Indivisibility

The resource may have physical traits that literally forbid parcelling; the production system may simply not be amenable to physical division or demarcation. Either the resource system cannot be bounded (the high seas, the stratosphere) or the resources we care about are mobile over a large territory (air, water, fish, wildlife). Land, particularly forests, may seem much more divisible (and fenceable) at first glance than other kinds of resource systems, but in fact where forests are being managed not only for products that can be taken from it but also for their value in protecting water and soil, not to mention local climate, forests need to be managed in large units of at least the size of watershed basins. Basically, these resources have to be managed in very large units. Humans have only recently acquired interest in biodiversity, but leaving natural systems unparcelled and managing them in large units multiplies the biodiversity provided, sometimes exponentially, compared to managing the same acreage in separated parcels.

Uncertainty in location of productive zones

In fragile environments, nature may impose great uncertainty on the productivity of any particular section of a resource system, and the location of the unproductive sections cannot easily be predicted from year to year, but the "average" or "total" productivity of the entire area may be fairly steady over the years. Management efforts focused on the entire system are not plagued with uncertainties and may therefore be quite successful. In this situation, the resource system holds still and may even have fairly obvious boundaries, but the productive portions of it do not hold still. In effect, nature imposes compulsory fallowing on some resource systems by randomly rendering portions of them unproductive. In such resource systems, resource users may well prefer to share the entire area, and decide together where to concentrate use at a particular time, rather than parcelling the area into individual tracts and thereby imposing the risk of total disaster on some of their members (those whose parcels turn out to be bad ones that year). Creating a common-property regime is a way of acknowledging that this risk is substantial, and sharing it rather than imposing all of the risk, randomly, on some particular users each year.

Productive efficiency via internalizing externalities

In many resource systems, hilly ones for instance, uses in one zone immediately affect uses and productivity in another: deforesting the hillside ruins the water supply and downhill soil quality. If different persons own the uphill forests and the downhill fields—or, for that matter, small adjacent patches of forest and pasture—and make their decisions about resource use independently and separately, they may well cause harm to each other. If these externalities are substantial, they will want to negotiate Coaseian contracts with each other (Coase, 1960). Either the downhill farmers would pay uphill forest-owners not to cut all the trees they might want to, or uphill forest-owners would cut all the trees they want to and instead compensate downhill farmers for damaged fields with the extra earnings from timber sales.

An institutional alternative to this series of bilateral exchanges is to create a common-property regime to make resource management decisions jointly, acknowledging *and internalizing* the multiple negative externalities that are implicit in resource use in this setting. People who use a common-property regime to manage their uphill forests all share ownership of the upland forests, restrain timbering to prevent soil erosion and damage to fields below, and earn more from their downhill farms than they sacrifice by not cutting as much uphill timber. Just as a Coaseian exchange permits people to enhance their joint efficiency by dealing directly with an externality, so joint resource management through common-property regimes may enhance efficiency by internalizing externalities. Common-property regimes may become desirable when more intensive resource use multiplies Coaseian considerations due to externalities between parcels. There is probably some threshold at which economies of scale in negotiating take over, and collective decision making, collective agreement on fairly restrictive use rules, and collective enforcement of those rules becomes easier (less time, lower transaction costs for the owners) than endless one-on-one deals.

Administrative efficiency

Even if resources are readily divisible into parcels, where nature is uniform in its treatment of different parcels so that risk and uncertainty are low, and where intensive independent use of adjacent parcels does not produce problematic externalities, the administrative support to enforce property rights to individual parcels may not be available. The society may be too poor to support a large court system to enforce individual land titles, and even cheap fencing would be expensive by this society's standards. Creating a common-property regime here is a way of substituting collective management rules—which function as imaginary fences and informal courts internal to the user group—for what is missing. It is cheaper in these circumstances, and it is within the power of a group of resource users to create (even if they cannot create a nationwide system of courts and cannot afford barbed wire). Common-property regimes can be particularly attractive in providing administrative efficiency when resource management rules can simply be grafted onto the functions of a pre-existing community organization.

In many situations, particularly where people are interested in making good use of a resource system capable of generating multiple products, more than one of these conditions applies. All around the world we have such situations: ecologically fragile uplands that make vital contributions to the livelihoods of poor people. The reasoning above would indicate that common property may be the most efficient form of property institution for such situations. We do seem to be increasingly willing to understand that nomadic pastoralism or agro-pastoralism based on common-property arrangements are the most productive use of arid lands that can support limited and occasional grazing and temporary cultivation but nothing else. The poor soils of the African continent, a geologic misfortune not likely to be remedied by humans,[7] may not tolerate much agricultural intensification and may need, in the long run, to be managed in large units with long fallowing periods—a situation for which common property is very well suited.

Even in resource systems that seem eminently divisible, where risk and uncertainty are low and uniform across the resource system, where externalities seem minor or manageable through individual contracting, and where administrative support for individually owned parcels is ample, there may be reasons to maintain common property at least at some level. Natural resource systems are fundamentally interactive—forests provide watershed control, species are interdependent in ways we are often unaware of, etc.—and may well be more productive in large units than in small ones. In order to optimize the productivity of their own parcel, owners of individual parcels may want to guarantee that owners of adjacent parcels stick to compatible and complementary uses on their parcels, maintain wildlife habitat and vegetative cover intact, allow wildlife transit, refrain from introducing certain "problem" species, and so on. In effect, owners of individual but contiguous parcels may have an interest in mutual regulation of land use—the equivalent of zoning.[8]

To review then: private property rights in resources evolve only when demand for those resources makes the extra effort of defining and enforcing property rights worthwhile, i.e., when resource use intensifies beyond some point. These may take the form of common property rights—individually owned rights to flow based on shared rights to stock—when it is impossible, undesirable, or very expensive to divide the stock (the resource base or production system) into parcels. A common-property regime consists of joint management of the resource system by its co-owners, and is more likely to exist when the behavior of individual resource users imposes high costs on other resource users—that is, as mutual negative externalities multiply. Vesting clear, specific, secure, and exclusive rights in private entities encourages investment and protection of resources. Vesting those rights in large enough groupings of individual resource users so that they can then coordinate their uses to match ecosystem requirements internalizes environmental externalities.

Embedded in this observation is a very important theoretical proposition. That is, mutual regulation through the institutional equivalent of a common-

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[7] *The African continent, having been the one from which other continental plates split off, was not fortunate enough to have been crashed into by other plates. It is this collision of plates that produces gigantic upwelling of old sea floors into new mountain ranges, and it is such mountain ranges that over geologic time erode into the rich alluvial plains of the world's breadbasket regions. The mountains formed (as in East Africa) when a plate slides across areas of volcanic eruption consist of molten lava with no organic enrichment, and although they too erode and contribute to topsoil, it is of much lower agricultural value (David Campbell, Department of Geology, Michigan State University, personal communication, 28 June 1995).*

[8] *In fact, zoning and urban planning are actually the creation of common or shared property rights in choices over land use, and the vesting of those rights in the citizens of a municipality. Just as zoning would be an absurdly unnecessary effort in a frontier area where population density is low but increasingly desirable—to control externalities—in more densely populated areas, so common property becomes more desirable, not less, with more intense resource use.*

property regime is **more** desirable, because of its capacity to cope with multiplying externalities, as resource use **intensifies** and approaches the productive limits of the resource system. Further, since it is people who use resources, we should also find that common property becomes **more** desirable—not necessarily more workable but more valuable and thus more worth trying—as population density **increases** on a given resource base. If human beings depend on extracting as much out of a resource system as the system can sustainably offer, then careful **mutual** fine-tuning of their resource use becomes essential. Common-property regimes are essentially a way to institutionalize and orchestrate this kind of fine-tuning when resource systems are pushed to their limits.

Private property rights stimulate long-term planning, investment in the productive quality of a resource base, and stewardship. Sharing these private property rights is a way to solve some of the externality problems that arise from population pressure and intensification of use. If we fail to solve these problems through Coaseian bargains or collective management of resources, we inevitably deplete those resources and reduce their productive potential well below what it could have been, if not all the way to zero.

Too many observers and policymakers today now throw up their hands in despair when they see population pressure and resource depletion, condemn common property as quaint and unworkable, and recommend privatization. But what they mean by "privatization," as they use the term, is either an outright award of the entire resource system to a single individual, without regard to the political consequences of enraging all other former users of the resource, or parcellization, rather than shared private property or common property that should be encompassed in the notion of "privatization." **The advocacy of "privatization," then, tends to overlook what may, in fact, be the most appropriate form of privatization in some instances!** I would argue that common-property regimes may be the most appropriate things to create where resource systems are under *both* environmental and population pressure, at least where prevailing cultural values support cooperation as a conflict-solving device. Like individual parcellization, common property gives resource owners the incentive to husband their resources, to make investments in resource quality, and to manage them sustainably and thus efficiently over the long term. But unlike individual parcellization, common property offers a way to continue limited harvesting from a threatened or vulnerable resource system while solving the monitoring and enforcement problems posed by the need to limit that harvesting. Sharing the ownership of the resource base is simply a way of institutionalizing the already-obvious need to make Coaseian deals to control what are externalities for a parcelled system and internalities for a co-owned intact system.

Attributes of successful common-property regimes

The findings to date from many individual case studies of successful and failed common-property regimes can be initially synthesized into a set of broad policy recommendations related to the conditions that are associated with successful common-property regimes (based on Ostrom, 1990; McKean, 1992b; and Ostrom, Gardner, and Walker, 1994).

User groups need the right, or at least no interference with their attempt, to organize. There is a stark difference between resource user groups such as those in Switzerland and Japan that have both legal standing as property-owning entities and long-documented histories of community resource management, and indigenous peoples from Kalimantan to Irian Jaya to the Amazon, and from Zaire to India, who have practiced community resource management for decades or even centuries but have no legal protection. As soon as products from the resource system become commercially attractive, persons outside of the traditional user community become interested in acquiring legal rights to the resource. If the traditional users have those legal rights in the first place, then they essentially have the commercial opportunities that their resources create. In Papua New Guinea, for instance, where traditional community forest rights are legally valid, portable sawmills used by villagers turn out to be more economically efficient overall, and to bring more wealth into the village, than timbering by multinational corporations. Where local communities' resource claims go unrecognized by national governments, the best they can then hope for is that higher layers of government will overlook them rather than oppose them. The farming villages of Andhra Pradesh that use an open-field system to manage planting, harvesting, grazing, and irrigation do so successfully only because and as long as the state and national governments ignore them (Wade, 1992).

The boundaries of the resource must be clear. It is obviously easier to identify and define both the natural physical boundaries for some resources—a forest or a pasture or a coastal fishery for instance—and the legal boundaries for a particular community's land, in contrast to the challenges of defining boundaries for, say, a highly mobile species of fish in the high seas. Once defined, these boundaries can then be patrolled by community guards. Clearly marked or even well-understood boundaries can be an inexpensive substitute for fencing. Indeed, fencing may be an effective barrier against some animals, but not against human beings, who can climb over most fences and, in any case, usually acquire wire clippers and saws at the same time they get hold of fencing material. Rather, the social function of fencing, one that can be performed equally well by unambiguous demarcation of property lines, is that it offers impartial notification of boundaries. Thus, those who invade others' territory know they are doing it, and those who are invaded can prove readily that they have been invaded. Fencing eliminates innocent error and ignorance as excuses for trespass and theft.

The criteria for membership in the group of eligible users of the resource must also be clear. The user group has to share solid internal agreement over who its members are, and it is probably best if eligibility criteria for membership in this group do not allow the number of eligible users to expand rapidly. Many Swiss villages limit eligibility to persons who live in the village *and* purchase shares in the alp, so that new residents must find shares to buy, and shareowners who leave the village find it in their interest to sell their shares because they are unable to exercise their village rights from elsewhere. Thus, the size of the eligible user group remains stable over time. Japanese villages would usually confer eligibility and shares of harvest on households rather than individuals, and were also likely to limit membership to long-established "main" households rather than "branch" households. These practices assured that no special advantages went to large households, those that split, or new arrivals. Not only did this rule limit the number of eligible users and the burden on the commons but it also discouraged population growth. Communities elsewhere may be less strict—at their peril—about defining eligibility for membership in the user group. Vondal describes an Indonesian village whose communal resources are under stress in part because the community opens membership in the user group not just to all village residents but also to all kin in neighboring villages (in McCay and Acheson, 1987). Thus, this user group has expanded rapidly, without any consideration yet for matching its size or its aggregate demand for resources to the capacity of the resource system.

Users must have the right to modify their use rules over time. Inflexible rules are brittle and thus fragile, and can jeopardize an otherwise well-organized common-property regime. In a magnanimous but ill-considered attempt to extend legal recognition to common-property regimes over forest and pasture land in the Punjab, the British decided to codify all of the rules of resource use in different systems. The undesirable consequence was to freeze in place use rules that really needed to remain flexible (Kaul, 1995). The resource users are the first to detect evidence of resource deterioration and resource recovery, so need to be able to adjust rules to ecological changes and new economic opportunities. If the commons displays signs of distress, the village might alter the rules so as to reduce or even eliminate the incentive for each family to cut all that it can when allowed entry into the commons. The village might choose to lengthen the period of closure on land that is being degraded. Or, it could alter distribution rules from allowing each family to keep what one able-bodied adult can bring out of the commons in one day during entry season, to aggregating the cut from each family, dividing it into equal amounts, and reassigning bundles of harvest to each household by lottery. Japanese villages that have retained full title to their common lands are not only free to adjust regular use rules as they see fit but are also free to take advantage of attractive commercial opportunities. They may hire loggers to clear 1/50 of the mountain each year for 50 years. They may "manage" the forest for commercially valuable bamboo or fruit trees. Villages in Kyushu often use their commons as pasture for animals. Or, villages may lease surface rights to hotels and ski resorts. They are even free to sell off the commons, by unanimous vote, if they want to reap the capital gains on appreciated land values.

Use rules must correspond to what the system can tolerate and should be environmentally conservative to provide a margin for error. Successful user groups appear to prefer environmentally conservative use, possibly to give themselves a margin to invade during emergencies. Japanese villagers in the Mt. Fuji area knowingly overused their commons during the depression of the 1930s (removing more fodder for packhorses and more wood for charcoal than they should have), but also knew that they—and the commons itself—could afford this in a temporary emergency of that kind precisely because they were intentionally conservative in their use during good times. The commons was both an essential part of everyday living and a backup system maintained in reserve. When forestry scientists told Nepali villagers that their forest could easily tolerate the extraction of both leaf litter and kindling, the villagers rejected this advice and opted instead to ban the cutting of fuelwood altogether, because they feared that allowing any cutting of wood would threaten the total population of deciduous trees and thus could reduce the supply of the leaf litter they used as fodder and fertilizer (Arnold and Campbell, 1986).

Use rules need to be clear and easily enforceable (so that no one need be confused about whether an infraction has occurred). Common-property regimes frequently establish quantitative limits on amounts of different products that an individual user may extract from various zones of the commons, but this means that a suspected infraction involves much measurement, weighing, and discussion between resource user and guard about whether this limit applies to that species or another one, and whether this kindling was collected from one zone or two, whether these branches are of too wide a diameter or not, and so on. Sometimes other kinds of rules can be simpler to understand and enforce. Restrictions on the equipment a user takes into the forest may be just as effective in restraining harvesting and also be simpler to enforce. Having too large a saw, or a pack animal rather than a backpack, might then be an infraction even before one begins to cut. Opening and closing dates are similar: being in the forest or on the pasture during the off-season is simply unacceptable, whatever the excuse. Clear enforceable rules make life easier for resource users and for monitors representing the user group, and reduce misunderstandings and conflict.

Infractions of use rules must be monitored and punished. Obviously, rules only work when they are enforced. Agrawal (1992) found that communities in Uttar Pradesh differ widely in the extent to which they devote village resources to enforcement, particularly hiring guards or assigning villagers to guard duty by some rotational scheme. The communities with healthy common forests were those that recycled the fines and penalties they collected into providing for their guards. The communities with degraded forests were those that had fewer guards, enforced the rules less, collected much less in fines, and put the fines into a general village budget rather than into the enforcement mechanism. There is also evidence that penalties need not be draconian: graduated penalties, mild for first offenses and severe only for repeated infractions, are adequate (McKean, 1992b; Ostrom, 1990).

Distribution of decision-making rights and use rights to co-owners of the commons need not be egalitarian but must be viewed as "fair" (one in which the ratio of individual benefit to individual cost falls within a range they see as acceptable). It comes as a surprise to observers who have romanticized the commons that common-property regimes do not always serve to equalize income within the user group. Communities vary enormously in how equally or unequally they distribute the products of the commons to eligible users. Decision-making rights tend to be egalitarian in the formal sense (one user household, one vote) although richer households may actually have additional social influence on decisions. Entitlement to products of the commons varies to a surprising extent. In some communities, especially in India, the commons do turn out to be a welfare system for the poor: the wealthy members of the community may be entitled to use the commons but do not bother to exercise that right because of the high opportunity cost of their labor, leaving *de facto* access to poorer members, those willing to invest their labor in collecting products from the commons. In other communities, including most long-lived common-property regimes (Switzerland, Japan, and virtually all regimes governing grazing and irrigation), products of the commons are distributed to families in the same proportions as their private assets off of the commons. If any subgroup feels cheated—denied "adequate" access or a "fair" share—vis-a-vis another subgroup, the angry subgroup becomes unwilling to participate in decision making, unwilling to invest in maintaining or protecting the commons, and motivated to vandalize the commons. An important key to the cohesiveness of farmer-managed (as opposed to government-organized) irrigation systems is the power of tailenders to withhold their labor from maintenance of canals, channels, and sluicegates when they feel that headenders are taking too much water. Successful irrigation systems have very well-calibrated mechanisms to distribute water in the same proportions as the labor required of co-owners (Tang, 1992). Rules that award more benefits to those who invest more, and no benefits to those unwilling to invest, seem to have the best chance of winning the allegiance of both rich and poor.

There need to be inexpensive and rapid methods of resolving minor conflicts. Successful common-property regimes assume that there will often be small disagreements among users, and provide regular opportunities for these disagreements to be aired and rules clarified or adjusted if necessary. Swiss commoners make Sunday church outings the regular occasion for discussing problems and collecting levies. Japanese villagers are so organized (it is not unusual to find more committees than households in a village) that they have constant opportunities to air grievances. Most conflicts can be resolved at a low level because persons with multilayered social relationships can usually design a satisfactory compromise.

Institutions for managing very large systems need to be layered with considerable devolution of authority to small components to give them flexibility and some control over their fate. Some forests, grazing areas, and irrigation systems may have to be managed in very large units, but at the same time the persons living near each patch or segment of the resource system need to have substantial and secure rights in the system in order to have the incentive to protect it. A large resource system may be used by many different communities, some in frequent contact with each other and some not. The need to manage a large resource system as a unit would seem to contradict the need to give each of that resource system's user communities some independence. Nesting different user groups in a pyramidal organization appears to be one way to resolve this contradiction, providing simultaneously for independence and coordination. The most successful examples of nesting come from irrigation systems serving thousands of people at a time (Ostrom, 1990, 1992).

It must be recognized that some common-property regimes falter and that other sorts of institutional arrangements can also work effectively. But it would be a grave mistake to dismiss common-property regimes as relics of the past, intrinsically unworkable, or incompatible with contemporary society. The theoretical arguments above indicate that there are circumstances where common-property regimes may be quite suitable, and there are, in fact, many documented cases where resource users themselves have crafted institutions consistent with our findings above. But there are still many gaps in our knowledge and information about the effects of diverse institutions on forest conditions. Before we destroy or create institutions willy-nilly, we need much continued effort to enlarge the body of information we draw upon in the effort to reduce rates of deforestation and loss of biodiversity around the world.

Although we are a long way from certainty about what makes successful common-property regimes work, I would be willing to offer the following propositions for devising common-property regimes:

—**sociocultural support:** Common-property regimes will work better where the community of users is already accustomed to negotiating and cooperating with each other on other problems than where there are numerous existing conflicts and no indication of a willingness to compromise.
—**institutional overlap:** Reviving recently weakened institutions, where the habits and techniques of negotiation and compromise are still in evidence, will be easier than trying to invent wholly new institutions among people who have never worked together before.
—**administrative support**: Reviving or creating common-property regimes where local and national governments are hostile is almost impossible. There is no point in trying unless local and national elites, or significant portions of them, are sympathetic to the attempt. This kind of support means legal recognition to strengthen the security and enforceability of common property rights.
—**financial support:** Apart from limited help with local start-up costs, financial support to local common-property regimes is probably *un*desirable because it might well undermine local cooperation. If an institutional form is being adopted because it is efficient, it should pay for itself (by definition!) and not require subsidy.
—**conflict reduction:** Where the size of productive management units permits a certain degree of segmentation or parcelling of the resource, it is probably preferable to create nonoverlapping commons for different communities rather than to have several communities sharing a single huge commons. It is probably best for the communities involved to make this choice rather than to have an outsider insist on splitting the resource system into several separate commons.

Common-property regimes are being promoted at long last in a number of resource-poor developing countries as a way of restoring degraded lands and building up a community resource base. I argue here that common property may be more appropriate than individual property when externalities among parcels of land multiply due to intensive use and high population pressure. It is crucial, then, not to eliminate common-property arrangements where they survive; but, rather, to view common property as a legitimate and very suitable variety of private property in some circumstances when conducting property-rights reform, and to pay careful attention to the nature of the resources in question (are they common-pool goods?) before tampering with property rights to those resources.

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Chapter 3

Group Size and Successful Collective Action: A Case Study of Forest Management Institutions in the Indian Himalayas

Arun Agrawal

Introduction

An increasing number of scholars, development practitioners, and environmental activists today forward microinstitutional solutions as the remedy for renewable resource scarcities. Their arguments have helped to shift attention away from market- or state-oriented policies as the only two alternatives to achieve development or environmental conservation (Anderson and Grove, 1987; Ostrom, 1990; Ostrom, Schroeder, and Wynne, 1993). The fresh claims on behalf of the local (Chambers, 1983; Korten, 1986; Uphoff, 1986), the indigenous (Cultural Survival, 1993; Denslow and Padoch, 1988; Richards, 1985), and the "little community" (Hecht and Cockburn, 1990; Scott, 1976; Wade, 1994) represent a long overdue move.[1]

The growing focus on community institutions and indigenous voices recognizes that national and international environmental trends are the aggregate consequence of the possibly independent concrete actions of millions of users. It accepts the rupture between the interests of local populations, and national governments and/or international institutions. But even more appropriately, the focus on the local marks

[1] The causes for the emphasis on local institutions may lie in the demonstrated deficiencies of state-directed development and the inability of markets to promote sustainable use of common resources. A large literature documents the vigorous debate on the merits and problems of pursuing development and conservation goals through state- or market-led policies. For useful introductions see Bates (1981, 1989), Repetto and Gillis (1988), Wade (1990), Wolf (1988). For critiques of both the market and the state see Shiva (1988), Escobar (1991, 1992), and Marglin and Marglin (1990).

a shift from the preoccupation with the centralized, overarching solutions of the past decades that failed to reverse, and may indeed have contributed to, environmental problems and attendant social tensions.[2] Existing state policies may have inflicted violence at multiple levels on everyday relations of existence and livelihood in rural areas (Colburn, 1989; Guha and Spivak, 1988).[3]

The attention to local spaces and communities, thus, forms a critical move in the conversation on development and conservation. The ensuing study builds upon the insights in this literature by interrogating the relationship between group size and successfully achieving collective action. Contrary to a large literature in the social sciences, I question the presumption that smaller groups are more successful than larger groups.

The study analyzes village *van panchayats* (forest councils) in *Almora* district in the Indian Middle Himalayas. These community-level councils help residents utilize and protect forest resources in accordance with rules they themselves craft and attempt to enforce. To meet the objective of the chapter, I first briefly describe the process behind the birth of van panchayats. I then examine the interactions between the interests of the British colonial state, and the actions of local populations, and how these led to outcomes that incorporated the interests of village communities. The story portrays how villagers and local communities are energetic agents rather than passive victims.

The sketch of the birth of van panchayats in the region sets the stage for seeking the solution to a puzzling finding of the research: the observation that larger forest communities find it easier to successfully organize for collective action to protect their forest resources. An enormous literature in the social sciences, inspired by the seminal work of Mancur Olson, has investigated why smaller groups are more successful in organizing collective action. The analysis is convincing. Rational individuals, acting in their self-interest, are unlikely to act in ways that would facilitate the provision of collective goods for a group, even if all group members share the same interests. Hammering this insight home, and in the process disrupting Marxist and pluralist arguments alike, Olson showed how smaller groups are better able to overcome the problem of collective action in comparison to larger groups.

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[2] *For a discussion of the relationship between renewable resource scarcity and social tensions see Gleick (1989), Homer-Dixon (1991), and Westing (1986).*

[3] *See Escobar (1991, 1992), Redford and Sanderson (1992), Scheper-Hughes (1992), Scott (1985), and Trainer (1985) for some critiques of market- and state-led development and conservation policies that ignore the interests of subaltern groups. The theoretical literature on the necessity of addressing local interplays of power and resistance often finds its inspiration in the works of Michel Foucault (see especially 1978, 1991a, 1991b).*

The findings reported in this chapter, however, undermine conventional wisdom. Building on the empirical observation that smaller van panchayats find it more difficult to organize successful collective action, the chapter discusses some significant theoretical reasons why larger groups may be more successful. After describing the basic characteristics of the communities among which research was conducted, I first attempt a local explanation of the success of larger van panchayats. The analysis is then elaborated to provide a more generally applicable theoretical explanation. In examining the relationship between group size and collective action, the study makes two major departures. Much writing on collective action focuses on the internal dynamics of a group. The chapter, rather, looks at the external dynamics—relations of a group with other groups. Second, it draws a distinction between mobilizing a group for collective action and success in meeting the objectives of collective action. Using these two ideas, it constructs an argument about why larger groups may be more successful than smaller ones.

The van panchayats of *Kumaon*

A multiplicity of institutional forms occupies the terrain of resource management in *Almora*. Three distinct regimes can be identified: (1) reserved forests controlled by the Forest Department, (2) civil forests managed by the Revenue Department, and (3) community forests managed by van panchayats. The activities of van panchayats are the focus of the investigation.

The history of the van panchayats in the Indian Himalayas can be traced to the intrusions of the colonial British state in the early 1800s. From this period onward, the British government made a number of inroads to curtail progressively the area of forests under the control of local communities (Guha, 1990: 44-45). Between 1910 and 1917 alone, the government transferred an additional 2,500 sq. kms. of forests to the Imperial Forest Department. At the same time, it also enacted elaborate new rules specifying strict restrictions on lopping and grazing rights, prohibited the extension of cultivation, sought to regulate the use of fire that villagers believed led to higher grass production, increased the labor extracted from the villagers, and strengthened the number of official forest guards (Pant, 1922).

The new rules stirred villagers into widespread protest. They simply refused to accept the rules, or the fundamental presumption undergirding them—the state's monopoly over all natural resources it deemed significant. The best efforts of the government officials failed to convince the villagers that the forest belonged to the government (Ballabh and Singh, 1988). The government had hoped that hill residents "would gradually become accustomed to the rules," but "the hill man (proved) impatient of control" (KFGC, 1922: 2). The incessant, often violent, protests by village communities forced the government to appoint the *Kumaon* Forest Grievances Committee to look into the local disaffection. The Committee examined over 5,000 witnesses from all parts of *Kumaon* in 1921 to make more than 30 recommendations. On the basis of these recommendations, the government passed the Van Panchayat Act of 1931. This act empowered village communities to create van panchayats and bring under their own control forest lands that were managed by the Revenue Department as Class I and Civil Forests.[4]

Nearly 3,000 van panchayats today formally control 35 percent of the hill forests in *Kumaon*. Of these, close to 1,700 exist in *Almora* alone (Agrawal, 1995: 51). The broad parameters that define the management practices of these institutions are laid down in the Van Panchayat Act. More specific content to the day-to-day management of community forests is the result of local action. Rural residents meet frequently, discuss the rules that will govern withdrawal of benefits from forests, and create monitoring, sanctioning, and arbitration devices to resolve the vast majority of management questions at the local level.They elect their leaders from within the community, select guards to enforce rules, fine rule breakers, manage finances, and often deploy earnings for the benefit of the community.[5]

This abbreviated history of the emergence of the van panchayats in *Kumaon* resonates with some critical issues in the social sciences. It shows—in contrast to much writing on local communities and peasants that treats its subjects as unwitting victims of a power-hungry centralizing state—that in the *Kumaon* hills, villagers significantly influenced government policies to reflect their subsistence needs. They organized themselves, resisted new state policies, and gained a measure of success in wresting back control over their forest resources. Of course, this is not to say that state-level actors do not seek greater control—as we will see, such objectives are at the heart of some recent modifications in the Van Panchayat Act. The actions of the villagers, rather, show that while macro-level political initiatives can significantly determine micro-level processes, the contours of such initiatives can also often be decisively shaped by organized social action undertaken by villagers.

Resources of the panchayats

The most significant products villagers traditionally harvest from their forests are fodder, fuelwood, animal bedding, organic manure, and construction

[4] *According to Somanathan (1989), the Act only formalized the control many hill communities had exercised over their forests before the arrival of the British. Their informal institutions were called lattha panchayats. Lattha means a big stick, and the name evocatively denotes the power the local community held over its members.*

[5] *Thus, they seem to meet many of the design principles that are characteristic of successful community institutions as discussed by Ostrom (1990).*

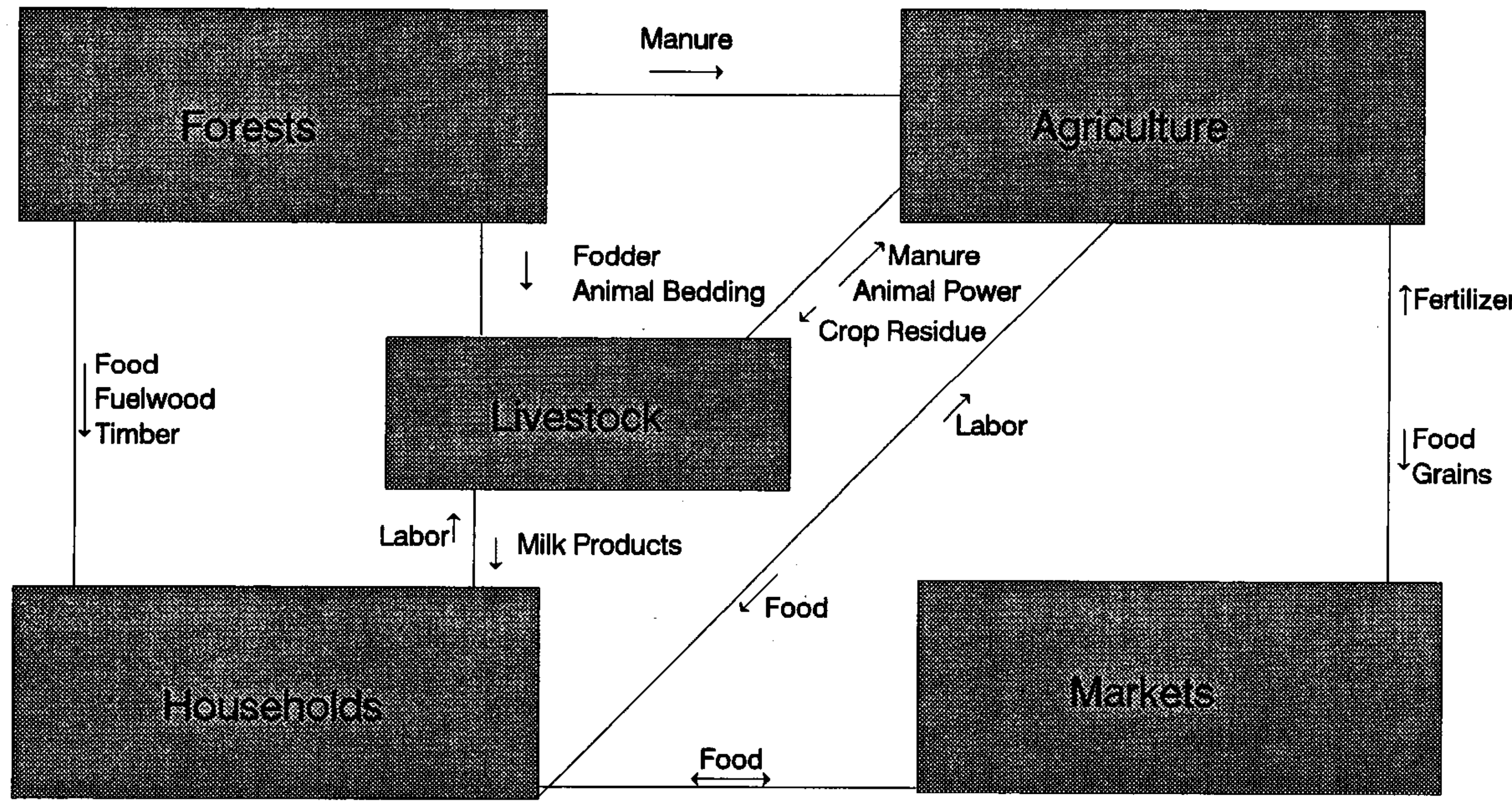

Figure 3.1: Forests in the hill subsistence economy

timber. Figure 3.1 outlines the importance of forests in the hill agricultural and subsistence economy by tracing the links between forest products villagers harvest, and the kind of needs such products fill. It is obvious that forests are the cornerstone of subsistence in the hills, contributing critical inputs to each element of the subsistence economy—the household, agricultural fields, and livestock rearing. In addition, panchayat forests containing chir pine (*Pinus roxburghii*) also yield resin for turpentine, a commercially valuable product.

Subsistence products from the community forests are usually available to all residents of the villages in which the van panchayats are located. The cash revenues from the distribution of the forest products are used to monitor and guard the resource, and to meet operational expenses of the panchayat. In some cases, panchayats have also had sufficient surpluses to create communal goods for their villages such as school buildings, or common utensils used to cook food for the community during festive celebrations.

Key actors

The van panchayats are embedded in a web of social and administrative relationships. These relationships presume the patterns of influence laid down in the Van Panchayat Act of 1931, as amended in 1976. While the Act provides for support to the van panchayats from the Revenue and the Forest Departments to facilitate rule enforcement and the maintenance of vegetation in the forests, it grants them only limited authority to enforce rules. Indeed, over the last several decades, the modifications in the Act and the manner of its application have significantly reduced the independence of the villagers. In the quotidian interactions of different actors that influence the performance of the van panchayats, higher-level government officials, especially those in the Revenue Department, have emerged as pivotal in the success of panchayats. That they were assigned supervisory and enforcement powers played a crucial role in the process.

As Appendix 3.1 shows, the powers of the panchayats, especially their enforcement authority, had suffered a substantial decline by 1976.[6] The overall framework of rules within which they could operate became far stricter. In addition, new restrictions on day-to-day activities meant they could fine rule breakers only with the consent of the rule-breaker, or once they secured the permission of higher-level

[6] *Ironically, it is the Indian state after independence that reduced the local authority of the panchayats even more than the colonial British state. Forestry and Revenue Department officials both felt that the Van Panchayat Act devolved too much authority to the villagers, and that the villagers had not been able to manage their forests well. In support of their arguments, they pointed to cases where, they argued, locally powerful individuals had engaged in large-scale felling and had been abetted in some cases by panchayat officials. Their arguments led to the increased restrictions through amendments introduced to the Van Panchayat Act in 1976.*

government officials. For major disputes they were required either to move the judiciary, or rely on aid from the officials of the Revenue Department.

As a result, those van panchayats that have few local resources at their command have been plagued by rule infractions. Their elected officials, lacking independent means to pursue court cases, and the requisite influence to move the officials of the Revenue Department, have often been helpless to enforce the rules they created. Asked in a meeting to list the four most important problems facing their panchayats, 30 van panchayat chiefs listed problems related to inadequate supervision and local rule-breaking and monitoring 68 percent of the time. In contrast, problems related to low cash incomes of the panchayats were mentioned only 32 percent of the time.[7]

At the same time, the officials of the Revenue Department who are supposed to help the panchayats must perform a host of other duties, including the maintenance of law and order, collection of taxes, and administration of various development projects. Most Revenue Department officials consider these duties to take priority over the tasks related to van panchayats. For many van panchayats, then, inadequate levels of enforcement and limited local resources are a major problem.

The case studies

Data on five van panchayats forms the basis for the ensuing discussion.[8] All of them are located in the Dhauladevi Development Block of *Almora* District. They range in elevation from 1,100 to 2,000 meters; their forests lie between 1,400 and 2,100 meters; and they are all close to motorable roads, and thus more or less equally exposed to market forces. In all, about 25 villages are located in the watershed of the river *Jataganga* of which 11 possess their own van panchayats. The rest depend on illegal harvests from the forests of their neighbors, and forests owned by the Forest or the Revenue Department. This watershed represents the situation in most of the *Kumaon* region. Forest resources are scarce, and villages compete for subsistence benefits from forests.

While the selected van panchayats and their settlements are situated within the same ecological and administrative divisions, they differ significantly on their size, organization, age, and resource endowments. As Table 3.1 indicates, Pokhri and Tangnua are very small in area as well as number of households, and have formed

[7] The 30 chiefs of panchayats listed a total of 97 problems. Of these, 31 (32 percent) related to the low income of their panchayat, 22 (23 percent) to inadequate support from higher-level government officials, and 44 (45 percent) to local-level rule infringements and problems in monitoring and enforcement.

[8] The selected panchayats were chosen randomly out of the 11 villages that possess their own community forests and panchayats in the Dhauladevi Development Block.

their van panchayats only recently. Kotuli and Bhagartola are relatively large. Kana, although it has a large aggregate area, still possesses only a small number of households. In Tangnua, the population has increased in the last two decades, but the number of households has remained more or less stable.

Table 3.1: Basic statistics on the five Dhauladevi van panchayats

	Pokhri	Tangnua	Kana	Kotuli	Bhagartola
Area (ha)	37	56	379	139	179
Cropped Area (ha)	12	14	230	36	59
Area of Van Panchayat (ha)	20	11	25	35	63
Distance from Road (km)	0.5	0	0	0.5	1
Elevation (M)	1,100	2,000	2,000	1,700	1,900
Number of Households (1993)	10	21	25	50	70

The small number of households carries some significant implications for the operations and budgets of the panchayats. The average annual number of meetings for Kana, Pokhri, and Tangnua lies between 2 and 4. For Kotuli and Bhagartola, it ranges between 8 and 12. Data from the meeting records of the first three panchayats indicates that they have also been relatively lax in creating rules to guide user behavior, and ineffective in enforcing the rules they have crafted. Thus, while the meeting records of Bhagartola and Kotuli contain lists of rule-breakers, the dates when guards detected rule infractions, and the amounts levied as fines, the minutes of meetings in Kana, Pokhri, and Tangnua are bereft of such details. By looking at the records one might conclude that no rules were ever broken in Kana, Pokhri, and Tangnua. Yet, in interviews and informal conversations, the members of these three panchayats invariably talked about limited resources and problems they faced in monitoring rule infractions. The absence of rule-breaking in formal records, then, is an indication of lax local supervision and enforcement (see Agrawal, 1994: 277).

In part, these differences among the five panchayats may simply indicate that because the first three are younger their officials as well as members need more experience: in working with government officials, in interacting with each other, and in forming and enforcing rules.

Such an explanation would be simple and attractive. Further examination, however, reveals its invalidity, at least for the selected panchayats. Records for meetings of the Bhagartola and Kotuli panchayats are available for analysis. These records reveal that they met regularly and often, and crafted a variety of rules right from birth. Their current organizational capacity certainly has developed over a period of time, but this cannot be taken to mean that time can be deployed as the explanatory variable for such capacity. A more favorable institutional and political-economic climate in the earlier period that helped establish the authority of the older van panchayats might still be playing a role in their continued survival and success. However, the current macroinstitutional environment has existed at least since 1976 and perhaps since Indian independence in 1950. It is difficult to accept that effects of a supportive environment have lingered on for 20 years or more, when everything around these village panchayats has changed. Further, it is important to understand how the activities and the processes within the panchayats relate to the macroenvironment rather than simply leaving the explanation toundefined historical changes.

A second difference that marks the first three panchayats is their meager budgets (Table 3.2). During the course of their existence, they have seldom been able to raise more than Rs. 750 a year to meet their expenses. Nor has their capacity to raise contributions from villagers increased over the period of their existence. Kotuli and Bhagartola, however, routinely raise between Rs. 2,000 and 4,000. Since all panchayats need money to hire a guard, or must be able to raise volunteer labor from members to substitute for the guard, the level of budget and contributions from members become significant elements in the successful functioning of the panchayats. Higher aggregate and per household contributions from member households increase the overall capacity of the panchayats to hire guards and enforce rules.

Table 3.2: Basic institutional information on van panchayats

	Pokhri	Tangnua	Kana	Kotuli	Bhagartola
Year of Formation	1989	1988	1991	1962	1939
Average Number of Meetings/Year	2	4	4	8	12
Total Annual Budget in the 1990s (Rs)	300	500	670	1750	3800
Per Household Contribution (Rs)	30	24	27	35	54

To some extent, the ability of households to contribute to the van panchayats relates in a circular fashion to the condition and type of vegetation in the forest itself, making conclusive assertions hazardous. If villagers receive little benefit from the forest, they will have little incentive to contribute to protect the forest. In a vicious cycle, then, the degraded condition of forest will worsen still further, discouraging future contributions. Too much, however, can be made of such a connection. In a condition of generalized poverty in the hills, where few, if any, of the households can be viewed as prosperous or even reasonably well-off, why do we find "institutional robustness" (Ostrom, 1990) in some cases, and miss it in others?

In the case of the van panchayats, the above explanation is simply off the mark. The per capita forest area in the case of all the panchayats is low, but no lower for the first three panchayats than for the Bhagartola and Kotuli, which are more successful. In addition, more than a third of the residents in all five cases, including the less successful first three villages, initiated the process of forming the panchayats; most of the other villagers were willing to experiment. Villagers in all the five cases find significant proportions of their subsistence needs for fuelwood, fodder, and construction timber in the panchayat's forests. Even in the smaller villages, there have been some contributions to the panchayat coffers—all of these indicate that the problem is somewhat different from what the postulation of a "vicious cycle" suggests. It is related more to the inability of small groups of poor households to generate a surplus for protecting commonly owned and managed resources, rather than to their unwillingness.[9]

Implications of the study

The salient features of the situation can be summarized. A number of van panchayats compete with each other to protect, and subsist on, their scarce forest resources. While the per capita endowment of forest resources is similar across the panchayats, the absolute size of the panchayats varies, both in terms of area and households. The rural context remains one of high levels of dependence on forests and low levels of income. Smaller van panchayats have found relatively less success in protecting their resources. This last finding of the study is worth considering at greater length.

The success of the larger panchayats is reflected in the greater number of meetings held each year, the more rules crafted, the larger budgets, the higher levels of monitoring and enforcement, and even, a relatively more dense vegetation cover.

[9] *It should be obvious that even if the problem relates to lack of incentive to contribute in the smaller communities, the larger argument in this chapter holds—smaller groups find it more difficult to successfully organize collective action.*

The figures for the "total tree biomass" in Table 3.3 provide some indication that the larger van panchayats have been more successful in protecting their forests.[10]

Table 3.3: Tree biomass and diversity in investigated cases

	Pokhri	Tangnua	Kana (Para/Gare)	Kotuli	Bhagartola
Trees per Ha	1103	2104	1825/ 1160	2460	1826
Mean Tree DBH (cm)	.1706	.1487	.117/ .1423	.1646	.1572
Mean Tree Height (M)	7.1	4.5	5.9/8.1	5.3	6.3
Total Tree Biomass (CuM/Ha)	179	166	116/149	301	205
Number of Tree Species	5	9	23/7	13	11
Major Species[a]	Chir	Chir	Utees, Ainyar, Kafal, Banj, Burans, Chir	Chir, Banj	Ainyar, Chir, Banj
Number of Plots Sampled	16	9	11/9	26	18

[a]Indicates species that comprise more than 10 percent of the total number of the trees in the forest.

According to most writings that explore the relationship between collective action and group size, the probability of collective action becomes progressively bleak as group size increases. The data on five van panchayats indicate, however, that smaller groups may find it too arduous to create viable institutions that will persist over time to encourage collective actions. The larger van panchayats, on the other hand, are more successful in creating and maintaining processes that would organize their members and ensure their contribution to forest protection.

Two reasons can be advanced to explain the success of larger van panchayats. Each relates to protection of forests from unauthorized users and uses. To

[10] *Since the Kana, Pokhri, and Tangnua van panchayats have formed recently, the condition of the vegetation in their forests, unlike the cases of Kotuli and Bhagartola, cannot entirely be attributed to the manner in which the panchayat has functioned. But the relatively lax enforcement of rules in the three panchayats implies there will be little improvement in the condition of the forest.*

protect forests successfully in a context of generalized pressure on resources, communities need guards who will enforce rules. But guards who will monitor the condition of forests and prevent rule infringements cannot be hired without a minimum level of surplus. The smaller communities of poor peasants find it difficult to contribute even the relatively modest amounts that are necessary to hire a guard. As group size increases, it becomes easier to organize a surplus and commit it to monitoring and enforcement (Thomson, 1977; Agrawal, 1992).

Second, smaller communities also find it more difficult to prevent residents of other villages from coming and breaking rules related to forest use. In any dispute with residents of other villages they command fewer resources, such as voluntary labor or monetary contributions, that would enable persistence in imposing sanctions on rule-breakers.[11] The problem becomes especially acute in the absence of adequate support from the Revenue Department and other higher authorities. If a village community cannot raise sufficient resources to hire a guard to detect and prevent rule infractions, it is unlikely to possess the resources needed either to influence higher-level government officials, or to move the notoriously slow Indian judicial system to resolve disputes. Thus, on both counts—hiring a guard and influencing higher-level enforcement mechanisms—smaller communities are disadvantaged.

The finding that relatively larger groups found it easier to protect their forests successfully permits us also to engage the impressive theoretical literature on the relationship between group size and the probability of collective action. Before Mancur Olson's celebrated *The Logic of Collective Action* in 1965, Buchanan and Tullock (1962) inquired into the circumstances under which rational individuals would organize themselves to produce collective goods. According to them, as group size increases, the costs of decision-making externalities fall but the costs of coordination rise (1962: 63-64). As a result, medium-sized groups are most likely to organize themselves for collective action. Their discussion, however, assumes well defined and enforced property rights and focuses primarily on the internal dynamics of a group rather than on the results of competition between asymmetrically sized groups. In the situation we consider, it is precisely the delineation of property rights over forests, and their enforcement, that are issues of contention.

Olson's seminal work points to the importance of group size itself in determining whether collective action will be undertaken. According to him, "unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, *rational self-*

[11] *Voluntary labor and monetary contributions may both be necessary to discourage local rule infractions and resolve disagreements by arbitration or civil suits.*

interested individuals will not act to achieve their common or group interests" (1965: 2, emphasis in original). Focusing on the internal dynamics of groups by examining the motivations of individual members, Olson shows that groups will form to supply collective goods only under restricted conditions—and that these conditions are more likely to be met in small rather than large groups. As he puts it, "the larger the group the farther it will fall short of providing an optimal supply of a collective good" (1965: 48).

In the wake of Olson's work, a number of studies have focused on the impact of group size on collective action. Hardin (1982), for example, summarizes a number of earlier works (Buchanan, 1968; Chamberlin, 1974; Frohlich and Oppenheimer, 1970; Guttman, 1978; Hardin, 1971) to disentangle the effects of the nature of the good, the relation between the costs of collective action and benefits of the collective good per group member, and the likelihood of collective action. A large number of later studies have also tried to relate the possibility of collective action with group size, heterogeneity of member interests, reciprocity and interdependence, and marginal per capita returns from the provision of collective goods (Isaac, Walker, and Williams, 1994; Komorita, Parks, and Hulbert, 1992; Massey, 1994; Oliver and Marwell, 1985, 1988; Rapoport, Bornstein, and Erev, 1989; and Yamagishi and Cook, 1993). These studies have substantially enhanced our understanding of the impact of group size on collective action, and of collective action in general.

The example of the van panchayats in *Kumaon*, however, highlights some of the significant aspects of the relationship between group size and collective action that merit greater attention. The following discussion builds on existing studies of collective action by making two major points. It calls into focus the external dynamics of a group with other groups; and second, it makes a distinction between the formation of a group and achieving the objective for which the group was formed.

Most existing studies have focused only on the internal dynamics of the group—the relationship among group members. Following Olson's forceful focus on the rational, self-interested individual as the constituent unit of all groups, later studies have also focused primarily on the individual and his/her relation to collective action. In the process, they have ignored the impact of external relationships of a group with other groups. They have seldom considered how in a situation where different groups compete over resources, surely a widespread phenomenon, group size may be positively related to successful collective action.[12]

[12] *Rapoport, Bornstein, and Erev (1989) do consider how differences in group size may affect the probability of collective action when such groups are competing with each other. On the basis of their experimental results, they conclude that group size does not have any effect on provision of collective action. However, the group size for their experiments varies between 3 and 5. It seems hasty to draw the conclusion that group size has no impact on the probability of success, on the basis of such minimal variance in group size.*

The logic is devastatingly simple, almost "tautological," as Hardin (1982: 38) characterizes part of Olson's argument. Most villages in the hills already exist as groups. Individuals are born into these groups. The choice they face, then, is not whether to join a group. Rather, they must choose to *not* join a group of which they are already members by birth. Their calculus is not about the costs of joining; rather, it is about how expensive it would be to *not* join. In this situation, where individuals find it costly to leave the group, rather than to join, it should be obvious that larger groups would form more easily, and might even be more successful in protecting and managing their resources.

While villages already existed as informal groups, the Van Panchayat Act in 1931 lowered the cost of constituting the village as a formal-legal group protecting community forests. Government officials from the Revenue and Forest Departments encouraged local residents to create van panchayats. If villagers agreed, they could bring those areas of forests that were under the control of the Revenue Department under their own control. Further, owing to the scarcity of forest resources in the hills, villagers often are forced to harvest forest products in violation of existing rules protecting community forests. In the "drab everyday struggle" (Lenin 1902, rpt. 1976: 93) to protect their resources from others, then, it is not surprising that larger panchayats gain greater success than smaller ones.

Larger groups are more successful in two senses. A group that gains in size as more villagers participate in its activities is better able to raise more resources and expend a greater monitoring and enforcement effort. Two, if there are a number of different groups, some larger than others, the larger groups are more likely to be successful.[13] Both propositions in part rely on an added distinction between organizing collective action and success in achieving the objective of collective action.

Most studies on collective action have, by default, assumed that success in organizing a group (or collective action), and success in achieving the objective for which the group (or collective action) is organized, are one and the same thing. Under many conditions, the distinction is unnecessary—perhaps the reason why the obfuscation of this difference has survived for so long. Successfully organizing a march to protest abortion rights is synonymous with succeeding in the objective of organizing a march. But if the objective of the march is to overturn Roe v. Wade, success in organizing the collective action (march) is quite distinct from succeeding in its objective.

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[13] *In the second sense, the proposition has also found a defence from such theorists as Dahl and Tufte in their discussion of "system capacity" (1973: 20-21).*

In the case of van panchayats, successfully forming a group to protect village forest resources is a very different proposition from succeeding in protecting these resources. And while success in forming a group may come easier to smaller groups, success in protecting resources is easier for larger groups. What we should note is that successful collective action is not just about forming groups, it is as much about being successful in achieving the objective for which the group was formed.

The above distinction is not the same as the difference between initiating and maintaining collective action. To take the example of the van panchayats again, organizing the panchayats is distinct from making sure they are meeting regularly, which in turn is distinct from protection of local forests. The difference between initiating and maintaining collective action necessarily depends upon a temporal disjunction. But the difference between organizing collective action and achieving the objective for which the action was undertaken may or may not possess a temporal dimension. Once this distinction is made, it is easy to see that while smaller groups may find it easier to organize themselves, it is larger groups that will find it easier, in comparison, to succeed in achieving the objective for which they were formed. The logic would also operate at the level of the individual. Villagers, discovering that smaller groups find it harder to protect forests from rule-breakers, may well calculate that it does not make much sense to continue to contribute to an unsuccessful panchayat.

If it is true that as group size increases, at least for some range the likelihood of successful collective action will also increase, the natural question is: Would continued growth in size lead to lower likelihood of success at some point? It seems unlikely that groups could continue to grow *indefinitely*, even if continued growth is positively related to greater success in the achievement of objectives. While the studied cases have little to say about the effect of extremely large size on probability of success, ultimately the costs of coordination would increase sufficiently that they would outweigh benefits from increase in size (Buchanan and Tullock, 1962). The exact point at which this would take place, however, is a function of the context in which groups operate. In the context of the uneven topography of the Indian Himalayas, where natural factors such as limited availability of water, arable land, and forests constrain the growth of villages, the costs of coordination in existing villages are unlikely to become extremely high. Most villages comprise less than 200 households. One can then hypothesize the following: In small communities of poor users who use common-pool resources for subsistence, the likelihood of successful collective action to protect local resources increases as group size increases. It may, however, decline as group size becomes very large and creates extremely high costs of coordination.

The latter part of the hypothesis is based on the existing literature on collective action rather than on the data from the studied cases that provide only indirect indication of what would happen to the likelihood of collective action as group size becomes extremely large. It is because the costs of coordination would be very high for groups that are dispersed that smaller villages are unable to join each other to form larger van panchayats. For example, Kana, Pokhri, and Tangnua are more than six kilometers away from each other. They lack incentives to form a joint panchayat.

Conclusion

In conclusion, it may be useful to point to some practical relevance of the research. The findings reported here find significance from the most recent trends in Indian forest policy.[14] In a number of statements issued between 1988 and 1995, the central Indian government and the governments of 15 Indian states have sought to increase local participation in the management of Indian forests (SPWD, 1992). These Joint Forest Management statements constitute a break from the colonial forest policy that had continued in most parts of India, with only a few minor changes, even after independence. Yet, the changes introduced today are far more timid than the British Van Panchayat Act of 1931 examined in this chapter (Appendix 3.1). Most state policy statements allow local populations only a partial share in the benefits from protecting forests and do not permit them a voice in crafting the rules whereby the forests would be managed (SPWD, 1992; GOI, 1992, 1993). Without adequate support from enforcement officials, and without local mechanisms to ensure adequate protection—two provisions that are mostly absent from the pronouncements of the Joint Forest Management policies—prospects of success for the new policy may remain bleak.[15]

In addition, the research indicates that where groups are very small and compete for a share in local resources, their performance in protecting resources may improve if government policies create institutional incentives for smaller groups to join together. The attempts of very small groups of the poor to protect local resources on their own may founder because of limited ability to raise a surplus to enable effective local monitoring and enforcement. Finally, it may be kept in mind that if small groups are also highly dispersed, the external conditions might make it very difficult to create institutions through which they would coordinate their resource management and protection activities.

The relevance of the research for India is evident in the context of a declining forest base and changing forest policies. The research is, however, also significant in the context of the emerging international debate over the criticality of local

[14] *A number of governments in South Asia, including Nepal and Bhutan, are attempting to craft co-management programs with village communities for more effective forest use and protection.*
[15] *The Indian central and state governments, in formulating the new forest policy statements, seem, thus, to have ignored the lessons that the history of the van panchayats offers.*

communities and indigenous institutions in managing forests. The example of the forest communities in the Indian Himalayas suggests that autonomy to local communities must be supplemented by arrangements that will help protect local resources by creating user groups that are not too small, and will encourage dispute resolution within the same community, and among users from different communities.

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Appendix 3.1

Changes in the Van Panchayat Act between 1931 and 1976

Subject	1931	1976
Formation/ Dissolution	1. Two or more residents could propose the formation of the van panchayat for a village. 2. The Deputy Commissioner could dissolve a panchayat in case of repeated mismanagement or rule infractions.	Rule 2 remains the same. *Modifications:* 1. One third of the villagers must propose the formation of the van panchayat.
Membership	1. At least three, and at most nine, members elected to the van panchayat by villagers. 2. Panches select their leader as Sarpanch. 3. Panches could force resignation of individual members by a majority—the empty position could be filled from among right-holders by a majority decision of the panches. 4. All village residents, and others who possessed rights in the forest, could be right-holders in the panchayat forest.	Rules 2, 3, and 4 remain the same. *Modifications:* 1. Five to nine members to be elected to the van panchayat. 2. The Deputy Commissioner could nominate one member to the panchayat. 3. The Sarpanch could be removed from office by one third of the members, provided this step is approved by two-thirds of the members in a subsequent meeting.
Rules Regarding Resin Extraction	1. The Forest Department to be responsible for harvesting resin from chir pine trees. 2. Profits to be shared between Forest Department and the panchayat in proportions to be determined by the Forest Conservator. 3. Panchayat could harvest resin as long as it is in accordance with rules laid down by the Forest Department; and the resin sold to either the Forest Department or registered buyers. 4. Panchayat members could harvest resin for domestic use.	Rules 1, 3, and 4 remain the same. *Further Restrictions:* a. See modifications c, d, and e under the subject "Allocation of Income."

Subject	1931	1976
Rules Laid Down by Government	1. Panchayat forest land could not be sold, mortgaged, or subdivided. 2. The Products and proceeds from the sale of products of the panchayat forest to be used for the benefit of the community. 3. Panchayat to protect the forest and its trees. (But no explicit restriction on commercial sale of trees or timber.) 4. Panchayat to prevent villagers from cultivating the panchayat forest land. 5. Panchayat to demarcate the forest area. 6. The panchayat to maintain minutes of meetings, records of accounts, and make decisions in regular meetings. 7. Panchayat to follow the instructions of higher revenue officials. 8. Quorum required two-thirds of the members of the committee to be present. 9. All decisions to be made by simple majority.	Rules 1, 2, 4, 5, 6, 7, and 8 remain the same. *Further Restrictions:* a. All decisions of the panchayat to be made by two-thirds vote. b. Panchayat to meet at least once every three months; proceedings of the meeting to be recorded and copy submitted to the deputy commissioner. c. All extraction of timber beyond one tree requires permission from the Deputy Commissioner, Divisional Forest Officer (DFO), and the Conservator of Forests (CF). Any sales of forest produce must be in accordance to the working plans prepared for the van panchayat by the Forest Department. d. For commercial sale or auction of forest products (fodder, grass, minor forest products, firewood, timber), the permission of the DFO must be obtained. If the value of the auctioned products exceeds Rs. 5,000, the DFO must be present. All auctions above Rs. 5000 must be approved by the Conservator of Forests. e. The panchayat must prepare annual budgets and submit an annual report to the DFO each year. f. Special officers appointed to supervise van panchayats must oversee at least a third of panchayats each year. g. Van panchayat accounts could be audited.

Subject	1931	1976
Rights and Powers of Panchayats	In general, similar to forest officials: 1. Fine rule-breakers up to Rs. 5. 2. For offenses where the fine should be higher, the panchayat could file court cases against rule-breakers. 3. Levy fees from users for fodder, grazing, fuelwood, or construction stones. 4. Regulate grazing in the panchayat forest and impound animals that are found in the forest in contravention of rules. 5. Confiscate cutting implements used in contravention of panchayat rules. 6. Restrict/suspend rights of users who break rules regularly. 7. Appoint guards to monitor and enforce rules.	In general, similar to forest officials: Rules 3, 4, 5, and 6 remain the same. *Further Restrictions:* a. All appointments by the van panchayat require approval of the Deputy Commissioner. b. At least 20 percent of the area of the van panchayat to be set aside from grazing; could lease land for commercial use. c. Could compound fines on individual rule-breakers up to a limit of Rs. 50 with their permission, and up to Rs. 500 with the permission of the Deputy Commissioner; and to file court cases against rule-breakers. d. Could grant no more than one tree to a right-holder—written consent of more than half the panches, and stamp of Sarpanch necessary.
Rule Enforcement	All fines imposed by the panchayat were treated as government dues and recoverable using similar procedures.	Same as before.
Elections	Panchayat officals elected for three years. New elections to be held every three years.	Panchayat officials elected for five years. New elections to be held every five years.

Subject	1931	1976
Allocation of Income	1. All income from sale of forest products to right-holders as assigned to the van panchayat. 2. All income from sale of resin to be allocated in accordance with proportions determined by the Conservator of Forests (in practice it went to vanpanchayat). 3. Income from sale of forest products (such as timber, resin, minor forest produce) to non-right-holders was assigned to the van panchayat.	Rule 1 remains the same. *Modifications:* a. Forest Department to deduct 10 percent from all gross revenues of the van panchayat as its share to meet administrative expenses. b. Net income from commercial sale and auctions to be deposited in a Panchayat Forest Fund, managed by the Deputy Commissioner. c. Twenty percent of the net income allocated to District Council to meet development costs. d. Forty percent of the net income allocated to the Forest Department to maintain and develop panchayat forests. e. Remaining 40 percent of net income allocated to panchayat—to be spent on works of public utility as approved by the Deputy Commissioner.

Chapter 4

Successful Forest Management: The Importance of Security of Tenure and Rule Enforcement in Ugandan Forests

Abwoli Y. Banana and William Gombya-Ssembajjwe

Introduction

Uganda's forest resources are an essential foundation for the country's current and future livelihood and growth. Over nine-tenths of Uganda's energy requirement, for example, is generated by forests (Background to the Uganda Budget 1993-1994). Forests are also important for timber and for their role in increasing agricultural productivity. They support wildlife and other forms of biodiversity vital for the country's future heritage, as well as for generating foreign exchange through a tourist industry focused on the diverse flora and fauna of Uganda.

These valuable forest resources are disappearing rapidly. The 1992 Uganda National Environmental Action Plan (NEAP) estimated that deforestation was occurring in Uganda at the rate of 500 km^2, while the Food and Agriculture Organization (FAO) of the United Nations (1993) estimated it to be at 650 km^2 annually. If the rate of deforestation were to continue unabated, most of the forested area of Uganda would disappear within the coming century.

The proximate causes of forest loss are clearing for agriculture, pitsawing and logging for lumber, charcoal and firewood production. However, not all forests are experiencing this problem equally; in some forests we do not find overexploitation. If we can come to understand why certain forests do not experience overuse, perhaps these lessons can help construct management schemes that are more effective and sustainable.

Among the more important independent variables that affect the level and type of consumptive utilization of forests in many settings are the security of tenure that local residents possess related to forests and the level of rule enforcement related to the use of forest resources. These variables are important because individuals who lack secure rights to continued use of forest resources are strongly tempted to use up these resources before they are lost to the harvesting efforts of others. Further, if rules regulating access and use of forest resources are not adequately enforced, the *de facto* condition becomes one of open access rather than secure tenure.

In this chapter, we argue that the condition of forests in Uganda is related to the uncertain status of land and tree tenure regimes. In our study of five forests, we find that in those areas where a system of property rights is well-known to the local population and is enforced, the condition of forests is arguably better than in those areas where locals play no part in forestry management and national laws lack enforcement (NEAP, 1992). We also find that in addition to government-enforced rules, the recognition of indigenous rights to forest resources management led to successful management practices.

Forest use in Uganda

In order to establish the effect of the independent variables described above on the outcomes (deforestation or sustainable use of the resource), studies were conducted during the fall of 1993 in five selected sites located in Uganda's four agro-ecological zones (tall grasslands, short grasslands, semi-arid, and highlands).

Two forests were studied in the tall grassland zone in Mpigi District about 30 km west of Kampala. Two forests from one site were included because they represented a "natural experiment" in which very similar natural forest lands were divided into two forests with different tenure regimes and use rights. One of the forest patches is known as Namungo Forest, which is privately owned. Adjacent to Namungo Forest is a section of the Lwamunda Forest, which is a Government Forest Reserve. Both of these forest patches are tropical moist evergreen with closed canopies (Barbour, Burk, and Pitts, 1987) and are locally classified as medium altitude *Piptadenistrum-Albizia-Celtis*, after the three typically dominant species in this area (Howard, 1991).

From the highlands agro-ecological zone, we studied the Echuya Government Forest Reserve, located approximately 500 km southwest of Kampala in Kabale District. It is a montane forest characterized by *Arundinaria alpina* bamboo species and scattered *Dombeya-Macaranga* tree species (Banana et al., 1993a, 1993b). From the semi-arid agro-ecological zone, we selected the Mbale Forest

Reserve. This forest, a savanna grassland forest characterized by *Acacia-Albizia-Combretum* tree species and *Cymbopogon afronadus* and *Hyparrhenia spp*, is located approximately 70 km north of Kampala in Luwero District (Banana et al., 1993c).

Bukaleba government forest reserve, located 140 km east of Kampala in Iganga District, was selected to represent forests in the short grass agro-ecological zone. It is a wooded savanna grassland forest, characterized and dominated by *Combretum, Teclea*, and *Terminalia* tree species (Banana et al., 1993b).

Level of consumptive utilization

Local forest users consume a wide variety of forest products in all five forests. Some of these uses are legal; a great number are not. Significantly, the intensity and pattern of these consumptive uses vary across the forests.

In all five forests, local forest users are permitted to harvest forest products for subsistence use in "reasonable" quantities. Access to these forests for other benefits, such as recreation and cultural activities, is open to all local users. If forest users desire to harvest forest products for commercial purposes, however, they are required to purchase a monthly or seasonal license from the Forest Department.

The specific pattern of legal use in each forest, however, varies. In Namungo's Forest, the Namungo family (the private owner) has recognized the customary rights of the local residents located at the edge of his forest for the last half-century. These residents are allowed to harvest firewood, poles, craft materials, medicinal plants, water and fruits and wild foods from the forest (Gombya-Ssembajjwe et al., 1993). To monitor the use of this forest by local residents, Namungo employs a staff. The adjacent Lwamunda Forest Reserve, which is a government forest reserve, has also been used by local residents for harvesting similar products. Prior to 1981, selective logging of trees over 80 cm in diameter by logging companies had been permitted and carried out in both Namungo and Lwamunda Forests. Locals living near the Echuya montane forest use bamboo stems extensively for firewood, poles, thatch, and fibres. In Bukaleba and Mbale Forests, the *Acacia-Albizia-Combretum* tree species that dominate are used extensively for commercial charcoal production by the local people, and the *Cymbopogon afronadus* and *Hyparrhenia spp.* grasses are used as thatch and for grazing by local and transhumant grazers in the dry season (Banana et al., 1993a, 1993b, 1993c).

The pattern of illegal consumptive use by local people also varies widely. Table 4.1 contains data regarding illegal exploitation and disturbance collected from a random sample of 30 plots in each forest under study. The table categorizes five types of illegal activities observed in the plots: charcoal burning, pitsawing, commercial firewood collecting, grazing of livestock, and agricultural activity.

Table 4.1: Number of sample plots with evidence of illegal consumptive disturbance (N=30 per forest)

Name of Forest	Charcoal	Pitsawing	Commercial Firewood	Grazing	Farm	None
Namungo	1	2	2	0	0	25
Lwamunda	3	8	10	0	0	9
Mbale	10	1	5	22	4	4
Echuya	0	0	3	1	0	26
Bukaleba	0	0	12	2	5	11

Note: In some sample plots, more than one type of disturbance was observed.

Distinct patterns emerge from the data. The plots in Lwamunda, Mbale, and Bukaleba Forests endure considerable illegal consumption activities. Mbale, for example, bears the highest level of disturbance, with all but four out of thirty sample plots showing evidence of illegal use; the grazing of livestock appears to be the most frequent of illegal activities within Mbale Forest. In the plots of Lwamunda and Bukaleba, the commercial collection of firewood seems to be the most regular illegal use, observed in at least a third of the sample plots in each forest.

Overall, about 70 percent of the sample plots in Lwamunda, Mbale, and Bukaleba forest reserves showed evidence of illegal consumptive utilization of one form or another. In Namungo and Echuya Forests, however, only 20 percent of the sample plots show such illegal consumptive use in each of the five categories. In Namungo Forest, no type of illegal use appears in more than 10 percent of the plots, while in Echuya Forest, three of the five types of illegal uses were not observed at all.

To investigate how the illegal consumptive uses presented in Table 4.1 affect the physical condition of the forests, physical data were collected in each of the sample plots as well. The methodology for the data collection began with the demarcation of three concentric circles in each plot. In the first circle (1-meter radius), the amount of groundcover by species was estimated. In the second circle (3-meter radius), shrubs and tree seedlings were identified and their heights measured. In the third circle (10-meter radius), all trees were identified, their stem diameter at breast height (DBH) measured, and their heights estimated.

It can be noted that the consumptive disturbances were not universally as high as they were observed to be in Lwamunda, Mbale, and Bukaleba Forests. Data collected for trees indicate that plant species diversity was slightly better in Lwamunda forest reserve (73 species/ha.) than in the privately-owned Namungo property (64 species/ha.) (Table 4.2). The higher species diversity value in the government reserve may have come about by gap formation associated with repeated selective harvesting (Becker, Banana, and Gombya-Ssembajjwe, 1995). When large trees are harvested, they form openings in the forest where a wide variety of seedlings may become established and compete leading to a higher species richness (Denslow, 1987). The fact that there were 30 species found in Lwamunda forest plots and not in Namungo Forest, and 13 tree species in the opposite comparison supports this view (Becker, Banana, and Gombya-Ssembajjwe, 1995).

Table 4.2: Summary of data collected for trees in plot samples of the pilot study forests

Forest	Species Richness	Stems/ha.	Mean Diameter DBH (cm)	Total Basal Area (M^2)
Namungo	64	362	23.4	19.0
Lwamunda	73	338	26.6	16.0
Mbale	28	164	15.0	3.0
Echuya	18	5556* 180**	4.6* 20.3**	9.2* 6.0**
Bukaleba	34	190	17.8	5.0

*** Bamboo**
**** Trees**

Species diversity was generally low in all of the sites in the Savanna and Montane forest zones. The number of species observed in these zones was limited to 28 in Mbale Forest, 32 in Bukaleba Forest, and 18 in Echuya Forest.

The distribution of different tree-size classes were similar in Namungo and Lwamunda Forests (Table 4.2). Both forests were dominated by trees having diameter range of 10-40 cm. Very large trees with diameters greater than 80 cms were rare, representing less than 2 percent of the trees, thus reflecting past logging activities in these forests. Tree-size class distribution was also similar in Mbale and Bukaleba. Both forests were dominated by small trees having diameter range of 10-20 cm. Mature trees had been harvested for firewood and charcoal. Trees were larger in Echuya Forest, where tree harvesting is prohibited.

The data demonstrates that not all forests are being used at the same rate, or in the same manner, by the people living near them. Degradation was not found to be as extensive in Namungo and Echuya Forests as it was in Lwamunda, Mbale, and Bukaleba Forests. These latter three forests show serious signs of "open access" utilization that, if left unabated, could lead to a local fuelwood shortage, substantial forest degradation, and loss of useful biotic resources and amenities.

The role of tenure and enforcement

Security of tenure of natural resources is an important issue if local communities are to use sustainably natural resources in their localities. Tenure is a set of rights that a person or some private entity holds to land or trees (Bruce, 1989). It includes questions of both ownership and access to resources. Tenure determines whether local people are willing to participate in the management and protection of forests (Bromley, 1991/92).

During the colonial period, indigenous peoples' rights to harvest and dispose of trees was significantly restricted. Similarly, after independence, Uganda's forest policy, like many other developing countries, has been characterized by the strong concentration of power over forest resources in the central state apparatus, and the corresponding lack of local participation in forest and tree management.

Failure to recognize indigenous systems of forest management and indigenous rights to resources has led to:

- loss of incentives by the local communities to protect trees;
- discouragement of local people to engage in tree planting and reforestation projects; and
- excessive reliance by the state on punitive measures to enforce the law.

Lawry (1990) argues that where forest habitats have little economic value to local people because of restrictive access rules, sustainable local management institutions are unlikely to emerge. Incentives for conservation by local people can be improved by increasing the value of the resource to local people by, for example, granting more access rights or by granting local communities a percentage of forest concession revenues. None of these measures have been adopted by the Forest Department.

Insecurity of land and tree tenure may explain the observed general degradation of the forests throughout Uganda. A centralized state policy that is not backed with enough resources to enforce its rules has led to the condition where most forests in Uganda are *de facto* open-access resources.

And yet insecure tenure alone does not explain the observed variance of degradation that we found in our study's forests. The most significant difference between the forests is the high level of illegal consumptive utilization of Mbale, Lwamunda, and Bukaleba Forests and the lower level of illegal use in Namungo and Echuya on the other. To account for this variance, we turn to an explanation that features the enforcement of rules at the local level.

Although all forest reserves had clearly defined boundaries, the study reveals that monitoring is difficult and costly in Lwamunda, Mbale, and Bukaleba because these reserves are large with long borders, requiring many forest guards to monitor them effectively. The financial and human resources available to the Forest Department, however, are inadequate to carry out the task of policing these forests. In addition, the government officials (forest guards, forest rangers, and forest officers) who monitor and enforce the rules are poorly paid and, thus, not motivated to carry out their duties. As a result, forest users who choose not to comply to the rules can easily escape detection. This allows individuals to use forests illegally and, hence, leads to forest overexploitation.

The Echuya and Namungo Forests, in contrast, have a much greater level of monitoring and enforcement. Namungo's Forest is small (60 ha.) with short borders and a path around two sides of it. Namungo's family lives on one side of the forest and the settlements are on the other side. Since Namungo values the forest for his own rights to harvest timber (after due notification of his intention to harvest) and employs farm workers who can be forest guards for part of each day, his forest has more guards than an average government reserve. Additionally, because local residents are allowed to exercise their traditional rights to harvest forest products (e.g., firewood, poles, medicines, fruit, fodder, and other forest products), residents tend to protect actively the forest against outsiders who try to use Namungo's Forest. Thus, the level of rule enforcement in Namungo's Forest is relatively high, both because Namungo employs private guards, but also because locals enjoy strong and secure rights to products within the forest. The advantage of the forest's small size, short borders, and perimeter path around two sides helps to make monitoring more effective.

Like the more illegally used forests of this study, Echuya is a large government reserve. But certain important features of Echuya help to limit the amount of illegal consumptive use. Although subject to the same constraints on manpower and resources that discourage other government guards from effectively enforcing the national rules, the Forest Department staff in Echuya has augmented its monitoring capabilities by using the help of a pygmy community. The department allows the pygmies the right to live within, and appropriate products from, the forest on a daily basis—rights that other local residents do not possess. Because they live within the forest, the pygmies are in a good position to monitor who is harvesting from the forest, especially since locals are allowed by law to enter the forest only once per week (on Thursdays). Echuya's physical layout also helps protect it from over-exploitation. The Kabale-Kisoro road is the only road passing through the reserve and can easily be patrolled. Thus, while Echuya is large when compared to Namungo's forest, accessibility is difficult, the level of monitoring is significant, and the likelihood of being caught is quite high when harvesting illegally.

The department's reliance on the pygmies as forest monitors is effective for three reasons. First, because the pygmies do not live with the rest of the community, they do not fear retaliation from those they report to the Forest Department staff. Second, pygmies are less likely to collude with other local residents in breaking rules since there is no social interaction between the two communities. Third, pygmies have an incentive to protect the forest on which they depend on a daily basis.

In the other three forests, actions of local people suggest that unrestricted, unplanned, and illegal exploitation—as indicated by the levels of disturbances or illegal harvest—is not effectively prevented. The officials who govern these three resources have not minimized opportunities for activities that lead toward the rapid deforestation of these sites.

In order to comply with the rules regulating use of a resource, local users must be aware

- of possible consequences of not complying with the rules;
- that there is sufficient monitoring of rule compliance; and
- those individuals who abstain from obtaining forest products illegally must not at the same time witness a large number of their neighbors obtaining substantial income from breaking the same rules and regulations (Ostrom, 1990).

In Lwamunda, Mbale, and Bukaleba, the local people are aware that there is no effective rule enforcement. As a result, the state has created a *de jure* state property, but *de facto* open access. The absence of effective management and enforcement has turned these forests into a resource that can be exploited on a first-come-first-served basis leading to their overexploitation.

Conclusions

While it is difficult to address many of these issues with cross-sectional, rather than time-series data, this chapter has put forward a few assertions about the importance of tenure, enforcement, and forestry management at the local level in Uganda.[1] In this chapter, we argued that security of tenure and level of enforcement of rules are critical issues in forestry management. Using five cases from Uganda, we provided some evidence that supports the view that for successful forest management to be achieved in Ugandan forests, attention must be paid to both the rules that allocate property rights over forest products and how those rules are enforced.

This chapter indicates that forest resources are more likely to be sustainably utilized if an effective structure of institutional arrangements exists that gives rise to an authority system meaningful at the local level. A government forest reserve (state property) and a private forest (private property) can be as degraded as a communal forest (common property) if there are no effective institutional arrangements and associated organizational mechanisms to monitor and enforce rules in order to prevent wanton harvesting of the resource (Bromley, 1991/92). Regardless of the *de jure* property regime, all forests can be *de facto* open-access regimes if there are no effective institutions and mechanisms to enforce the rules.

Land and tree tenure insecurity discourage local participation in forest management and forest protection activities. This in turn increases the cost of monitoring and rule enforcement by the state. Part of these increasing costs can be met by employing locals to monitor in the place of regular national staff, as is the case in the Echuya forest reserve. But the long-term sustainability of a strategy that merely strengthens the enforcement of national laws is questionable. First, it would be difficult to replicate the situation in which a community of individuals is willing to provide monitoring services at an extremely low rate of renumeration, as are the pygmies. Second, a great deal of tension exists between the pygmy population and the others living around Echuya Forest. Pygmies, considered an inferior social group by most Ugandans, are generally treated quite poorly by the nonpygmy residents living near the Echuya reserve. This social tension could vitiate the forest management scheme that uses the pygmies as an extension of the Forest Department.

Given management institutions wherein local residents have a greater stake in the resources and management of a forest, it appears that successful forestry management might endure. Namungo's Forest appears to be sustainably used not only because of its guards, but because community residents are allowed to use the forest

[1] *IFRI protocols are designed to collect data over time, so we will return to these forests in the future in our attempt to untangle further these issues.*

according to traditional custom. This makes residents more motivated to discourage outsiders from invading the forest.

As Uganda searches for ways to manage its forests, the lessons from these five cases may be instructive to policymakers. State-centered policies appear to have failed in most Ugandan forests; the costs of maintaining a top-down institutional arrangement necessary to protect forestry resources are far too high. Alternatives that appreciate the preferences and capabilities of local communities should be weighed, not only because they appear to reduce the costs to the central state but because they appear to be more effective in maintaining forests in relatively good condition.

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Chapter 5

Social Norms and Human Foraging: An Investigation into the Spatial Distribution of *Shorea robusta* in Nepal

Charles M. Schweik

Introduction

Over the past decade, considerable attention has been given to the depletion of species in forests of the developing world (Myers, 1988; Aldhous, 1993; Repetto, 1988; Lovejoy, 1980; Task Force on Global Biodiversity, 1989; Norton, 1986; Reid and Miller, 1989). Often these studies take a macro view of the problem, focusing on general political or economic influences (Repetto, 1988; Richards and Tucker, 1988). A second research area shifts attention to the individual and searches for deeper understanding of influential variables that drive foraging behavior. Some of this literature focuses on the influence of institutions or rules in use that create or modify foraging incentives (Ascher, 1995; McKean, 1992; Thomson, Feeny, and Oakerson, 1992; and Appendix I to this volume).

Often micro-level studies utilize the forest area as a whole as the unit of analysis in which the researcher develops some measure of forest condition. Typically, these studies will (1) take a sample of vegetation using forest plots, (2) calculate species abundance indicators[1] from these plots, and (3) use these indicators to describe the current status of the forested area as a whole. If the researcher is fortunate, prior data on the forest exists and these newly generated indicators can be compared to ones developed from previous time periods. General conclusions can then be

[1] *Species "dominance," "frequency," "density," and "importance value" are commonly used species abundance indicators. The dominance of a particular species is a measurement of the biomass that the species contributes to a forested area. The frequency of a species describes how widely it is distributed within a forested area. The density of a particular species is a count of the number of individuals that are present within the area sampled. Finally, the importance value combines these three indicators to provide a general indicator of abundance of the species.*

made regarding the change in forest resources over time and the impact of current institutional arrangements governing the area.

While these forest-level analyses often produce quite valuable information regarding forest condition and forest governance as a whole, some information—perhaps important information—may be lost due to the aggregation of forest plot data. A hypothetical example may drive home this point. Suppose the abundance measure for a particular important species[2] of a forested area is determined to be quite high. A deeper spatial analysis[3] may reveal that the majority of these species are found in locations far from forager households.[4] At a forest level of analysis, the researcher concludes that the sustainability of the important species appears to be adequate. But from a plot level of analysis—a spatial perspective—an overharvesting problem exists. In this instance, aggregation yields false conclusions.

In addition, from an institutional perspective, aggregation to the forest level may lead to a lack of understanding of the foraging dynamics within a community. For example, the existing spatial distribution of a species may reflect the community's response to established harvesting rules. Designated protected areas that are effectively monitored may exhibit species abundance measures higher than in other unprotected areas within the same forest. To the researcher trying to understand how governance arrangements influence the harvesting behavior of foragers, a spatial analysis could be quite revealing.

The primary goal of this chapter is to develop a new methodology—using recent advances in Geographic Information System (GIS) technologies and maximum likelihood regression—to identify patterns in species distribution that differ from what we would expect in a natural, undisturbed[5] setting. The development of such a methodology helps analysts in two ways. First, it provides a way to identify forest depletion using data collected from only one time period. Second, it helps analysts understand the influence of institutional arrangements on species harvesting across space. The identification of spatial anomalies in a distribution help identify harvester reaction to the established institutional structure.

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[2] *An underlying argument made in this chapter is that more attention should be given to the analysis of important forest species in our studies of deforestation and biodiversity. The term "important species" is used to describe forest species that are found to be particularly useful by villagers for their day-to-day subsistence needs. Only by understanding what drives these species to be harvested or conserved will we fully understand why forest change has or has not occurred.*

[3] *The term "space" is used to describe the forested area or landscape of study. A "spatial" analysis investigates relationships between objects of interest exhibited over this landscape.*

[4] *This example is based on optimal foraging theory, which is described in further detail in a later section.*

[5] *The term "natural, undisturbed setting" is used to describe a setting in which the important product species is not disturbed by human activity.*

To achieve this goal, this study utilizes data from a recent International Forestry Resources and Institutions (IFRI) data collection effort in Nepal. Specifically, the study investigates two questions:

1. Does the spatial pattern of an important species found in a Nepali forest differ from what we would expect in a "natural," undisturbed setting?
2. Given the discovery of a disturbance in the spatial distribution of the species, what accounts for this outcome?

The chapter is organized in the following manner: First, I describe the study site, the species of interest, and the process used to collect the forest plot data. Second, I establish the theoretical foundation that guides the development of a "species density" model. This model—referred to as a trend surface regression model—contains a spatial component to address the research questions identified above. At this point, I also describe the operationalization of all influential variables. Third, I provide an overview of the statistical methods used. Specifically, I report the techniques used for identifying the natural, undisturbed spatial distribution of the species of interest and the results of the maximum likelihood regression. Fourth, I discuss findings of particular importance, and then conclude the chapter with some suggestions for future research.

Study site and data collection process

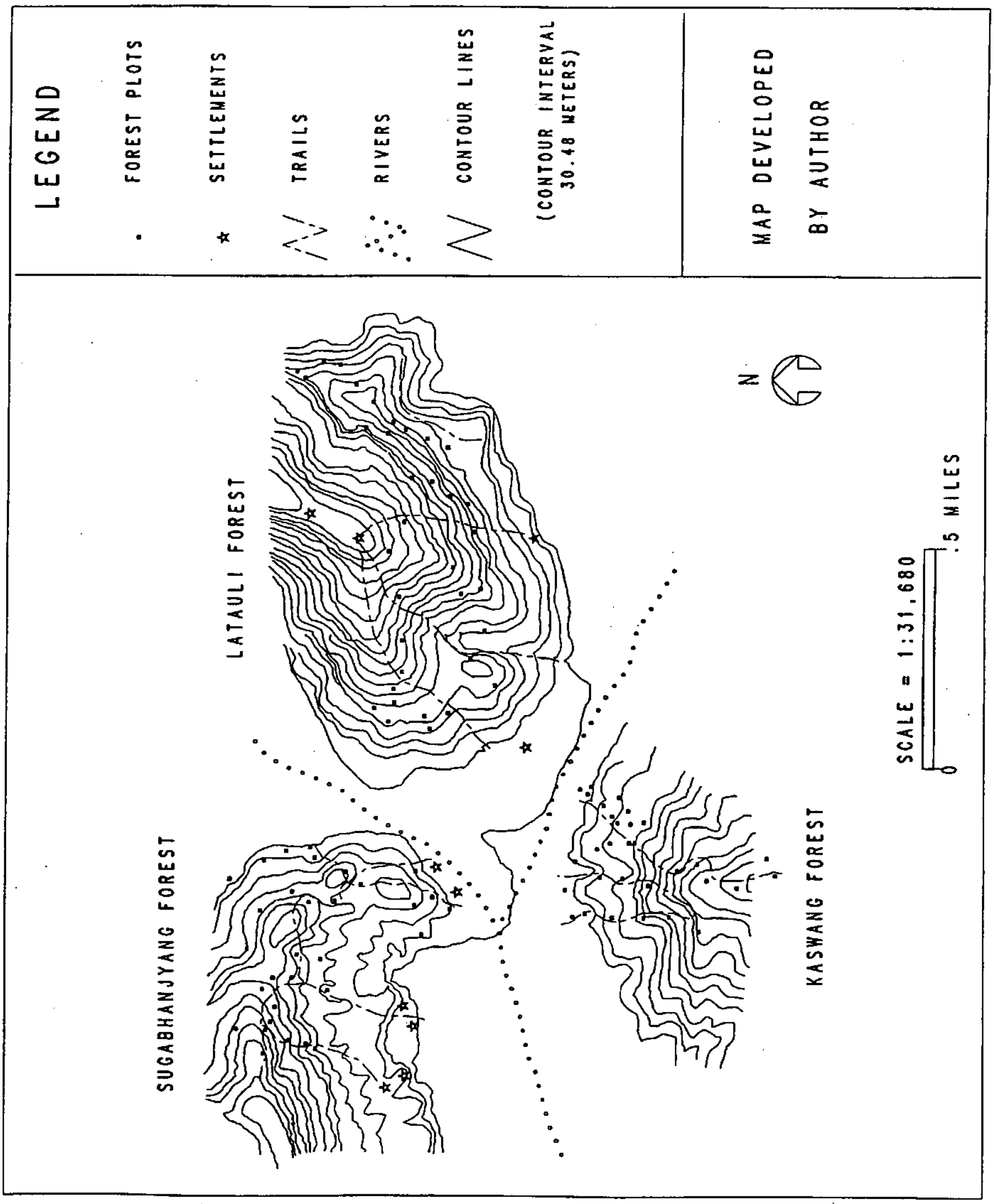
In October 1994, forested areas within the Shaktikhor Village Development Committee (VDC)[6] in the Chitwan District of southern Nepal were chosen for a study of forest governance. The project, a part of the larger IFRI research program, gathered information regarding forest management, use, and condition along with socioeconomic attributes of villages that utilize these resources (see Appendix I to this volume). A research team comprised of Nepali researchers[7] and the author spent six weeks living in the Shaktikhor area.

Ten settlements or villages comprise the Shaktikhor community, eight of which are located along the banks of two converging rivers (see Map 5.1). The majority of the villagers are subsistence farmers and depend heavily on forest products for their livelihood. Three forests[8] exist in the area: Sugabhanjyang, Latauli, and Kaswang. The villagers utilize these forests daily as sources of fodder, fuelwood, food products, and timber for construction activities.

[6] *A VDC is the name given to the smallest political-administrative unit in the Nepali governmental system.*

[7] *The research team is under the direction of Mr. Rajendra Shrestha, Director of the Nepal Forestry Resources and Institutions Consortium in Kathmandu, Nepal.*

[8] *The IFRI program defines a forest as an area larger than .5 hectares that is utilized by at least three households and that is governed by a similar legal structure (Ostrom et al., 1994).*



Map 5.1: Forest plot locations within the Shaktikhor area

For each of these forests, the team utilized ten-meter radius circular forest plots for sampling. Due to the steep terrain within these forests, the team followed trails to reach 50-meter altitudinal intervals. At each vertical location, a random number was used to determine the direction and the distance from the trail that the corresponding plot should be taken. Overall, 97 forest plots were sampled. Data recorded for each plot included:

- soil characteristics, such as the depth of the humus layer, and the depth and color of the "a" and "b" horizons;
- tree identification, including diameter at breast height, height and species type for each tree within the plot;
- sapling and shrub information;
- plot physiographic information, such as slope (in degrees), elevation (using an altimeter) and aspect (the direction the slope faces);
- ancillary observations, such as the existence of insect damage, signs of animal grazing, and evidence of human harvesting; and
- plot location, which was recorded on carefully drawn maps or collected using Global Positioning System (GPS) equipment.

All three forests are under the jurisdiction of His Majesty's Government District Forest Office (DFO). However, some community developed rules appear to exist. Detailed information was collected on specific rules in use—both rules as specified by the DFO as well as a few rules established and in use by local communities. This is discussed in further detail below.

A proposed "species-density" model

In order to investigate research question 1—the identification of unusual patterns in the distribution of an important species—this section estimates a maximum likelihood regression model. But before proceeding to a description of this statistical method, a brief theoretical discussion of important variables will be provided. In addition, for each theoretically important factor identified, the corresponding IFRI variable used to operationalize the concept will be presented.

The dependent variable: A measure of species abundance

The variable we are trying to explain in this study is the abundance of an important species within forest plots. The most important species reported by villagers (IFRI, 1994) in the Shaktikhor community is *Shorea robusta*, locally known as *Sal*. This species provides fuelwood for cooking, and timber for house and tool construction. *Sal* leaves are also highly valued for use in religious ceremonies. For these reasons, *Shorea robusta* is chosen as the species for analysis.

There are a variety of methods for measuring the abundance of *Shorea robusta* species in a particular plot. Species frequency, density, and importance value are measures widely used in the forestry literature and each could be an appropriate index. For reasons described more fully in the methodology section, the density (the number of individuals) of *Shorea robusta* trees per plot will be used as the dependent variable in the model.

The independent variables: Factors that influence the location of Shorea robusta growth

Many factors determine whether a species is found in a particular area. These influential factors can be divided into three categories: (1) Plot abiotic stresses, (2) Plot biotic stresses, and (3) Human stresses[9].

Abiotic stresses. Each forest plot contains physiographic characteristics that influence the capacity for particular species to grow in its environment. These characteristics include slope, aspect (or slope orientation), elevation, and soil type and condition. These attributes play a tremendous role in the number and type of species that exist within a plot (Spurr and Barnes, 1992).

Slope steepness, aspect, and elevation: These are crucial factors for determining whether a species exists in a given forest plot. These variables dramatically influence the ecosystem characteristics—exposure to sunlight, rainfall, etc.—that exist within the plot. Any model attempting to identify the important factors for species growth must control for these features. The field team recorded slope steepness with a clinometer and elevation with an altimeter. Global Positioning System equipment and topographic maps helped to cross-check elevation readings.

Soil type and condition: Soil nutrients, moisture, and physical composition are also highly influential factors in the growth and survival of particular species. Three soil horizons are typically reported in soil analysis: the "o" horizon (humus or ground litter layer), the "a" horizon (a darker mineral layer at the top of the soil), and the "b" horizon (the soil deeper in the ground). The color of these layers as well as textures (sandy, loamy or clayey) are also important determinants in what species can grow in the area. A soil analysis was performed on each forest plot and included depth, color, and texture of these horizons (IFRI, 1994).

Other natural disturbances: Other naturally occurring disturbances influence what grows in a particular area. A plot area may be subject to severe

[9] *Human stresses could be considered biotic variables (e.g., see Kozlowski, Kraemer, and Pallardy, 1991), but because of the importance of the human pressures in this study, I treat it as a separate category.*

weather damage caused by a lightning strike or a fallen tree. This damage results in renewed competition by the existing vegetation that survived. The IFRI forms record observations for each plot on natural disturbances, but very few disturbances were identified at the Shaktikhor site.

Biotic stresses. The number of a particular species within a plot is also influenced by a variety of biotic environmental stresses.

Species competition: Competing species in the forest plots are highly influential in determining whether another species can survive in a particular location. Competition for light, moisture, and nutrients exists in every plot, and species that can best tolerate the plot's conditions with respect to other species will have the best opportunity to grow. Since all trees in each plot were identified, measured, and entered into the IFRI database, this analysis uses a summation of the diameter at breast height (DBH) for species other than *Shorea robusta* within each plot.

Seed trees: Proximity of seed trees often determine if a tree will grow in a particular plot. The type of seed and its transportation medium influence where it may grow. The seed of a *Shorea robusta* is a samara[10] and may be carried a great distance by wind disturbances (Storrs and Storrs, 1990). While this is a difficult if not impossible concept to operationalize, this influence can be partially captured using data from forest plots that are identified as "neighbors." For this reason, a count of *Shorea robusta* neighbor trees in the most adjacent plot was included in the model.

Animal grazing: Animal activity also influences species survival within a plot. Animals forage for particularly tasty or nutritious species and these grazing habits often then determine the fate of many seedlings. In contrast, species not particularly interesting to animals may continue to survive or even thrive. The IFRI forms capture this concept by recording any signs of grazing found in forest plots. One possible limitation of this data is that it only captures the existence of grazing activities undertaken recently. However, many wild species forage from a central location (Stephens and Krebs, 1986) and consequently fresh evidence of grazing may capture long-term foraging in the area.

Animals also play a role in how species are replicated. Certain species have seeds that attach to an animal's fur or are consumed and deposited via droppings in other locations (Spurr and Barnes, 1992). Unfortunately, the data collected do not allow for an operationalization of this phenomenon.

[10] *A winged seed.*

Human stresses. A human's decision to forage or not to forage in a particular location is another important influence on whether a species exists in that location. Every forest plot exhibits additional characteristics that determine whether humans will harvest its resources.

Ease of access to plot (plot location): Optimal foraging theory developed by anthropologists depicts human foragers as actors who maximize their net rate of return of energy per unit of foraging time (Smith, 1983). While a number of alternative theories on foraging decision making exist (see Smith, 1983: 627), they all characterize the forager as a person who strives to minimize his or her search time and effort (Hayden, 1981; Winterhalder, 1993). What optimal foraging suggests is that the location of a plot in relation to villages may be an important determinant of the existence of *Shorea robusta* species. If humans harvest a particular species at a rate higher than can be regenerated by the forest, optimal foraging suggests that fewer individuals of that species will be found in locations easily accessed by humans (e.g., a short distance away from the village, near a path, or at a low elevation). The model captures this influence by including plot location.

In order to determine the location of forest plots, I created a three-dimensional representation of the forested area and produced X, Y, and Z coordinates for each plot. Two technologies—Global Positioning System (GPS[11]) and GIS—have made the collection and storage of accurate plots coordinates much easier. To create these data, I digitized contour lines from topographic sheets of the area and created a GIS representing real-world coordinates. Of the 97 forest plots sampled, GPS recorded the location of 31. I transferred these point locations onto the real-world contour GIS. I digitized the other 66 plot locations into the GIS using field maps, plot elevations recorded on IFRI forms, and personal knowledge of the field site and the location of trails. The result of this process was a plot location GIS (the output of which is Map 5.1) that is capable of identifying accurate plot locations and distances (in meters) relative to one another. I then utilized the GIS to produce X, Y, and Z (elevation) coordinates for each plot that are used as independent variables in the regression model.

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[11] GPS is a relatively new technology that uses a hand-held receiver to collect longitude, latitude, and altitude positions in the field. These receivers hold conversations with GPS satellites overhead and use trigonometry to calculate positions on the earth. Using a technique called differential correction, these recordings are accurate up to one meter. Differential correction was used on this data.

One rather exciting side note should be mentioned here on the use of GPS for environmental research. During this field visit, we mapped a land-use boundary using GPS equipment. This effort was unique in that the boundary <u>used</u> to exist and no longer does. We followed a knowledgeable villager and mapped the area <u>from his memory</u>. GPS appears to provide researchers with a mechanism that can collect <u>past</u> spatial relationships very accurately from the minds of villagers. It extends traditional participatory research techniques.

Property rights and species rules-in-use: Smith (1983) reports that empirical studies on optimal foraging theory have revealed that in some instances human foragers are selective in their utilization of available resources. Other studies have revealed foragers who exhibit much less concern. Smith also states that there is little agreement in the anthropological community over these foraging differences (1983: 628-29). While not stated specifically, Smith's discussion alludes to the importance of community relationships and the important role institutional arrangements play in the influence of human foraging patterns and their efforts for natural resource preservation.[12]

Ostrom (1990) extends Smith's argument by emphasizing the role of effective institutional arrangements in the use and management of natural resources. Institutions in this context refer to the working rules that govern the harvesting of a particular species or particular areas (what we might refer to as management units) within a forest. In the latter case, one particular plot may exhibit a higher density of a particular species in part due to the existence of rules that have set that particular area aside as a reserve. Foragers may bypass the plot area because these rules are accepted by the community.

Monitoring and sanctioning practices: Rules by themselves may not be particularly useful unless monitoring and sanctioning mechanisms exist that effectively enforce them (Ostrom, 1990). For example, a particular plot may be subject to better monitoring practices because of its proximity to a forest ranger post. Sanctioning differences may exist between plots due to established management units. A harvesting infraction in an area exhibiting a particularly delicate landscape (e.g., susceptible to landslides) may result in a stiffer penalty than an infraction in an area not susceptible to such disasters.

The IFRI forms obtain information about a large number of variables that encompass these concepts (Ostrom et al., 1994). Some institutional arrangements have been established at two different levels: the DFO (national) level and the VDC (local) level.

The DFO has an interest in the area because all three forests are designated DFO-owned land. There are three formally established DFO rules related to forest product use in this region. First, anyone who is a member of a VDC is permitted to harvest grass, tree fodder, and deadwood from forests within that VDC to support their

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[12] For example, Smith (1983: 632) describes the role that "exclusive control" plays in the conservation of natural resources. Feit (1973) describes rotational hunting by the Waswanipi Cree people as a method in which the size of animal population can be controlled.

daily subsistence requirements. Second, live tree harvesting is permitted only if formal permission is received from the DFO prior to harvesting. Third, a "no encroachment" rule exists that prohibits the conversion of DFO forest land to some other land use.

These rules are enforced by DFO forest guards who patrol an area greater than 100 square kilometers. Much of this area is extremely steep and hilly. Only one road exists, running just north and adjacent to the river below the Sugahanjyang Forest. This road runs from the western border of Map 5.1 and stops at the juncture of the two rivers. This road plays an important component to the rule monitoring conducted by DFO guards. The only DFO rule enforcement we witnessed during our weeks in the field occurred along this western road. Villagers report very little interaction with the guards, particularly in areas on the eastern side of the river juncture. Overall, DFO monitoring appears to be quite infrequent and, when it does occur, it is usually in the area of the Sugabhanjyang Forest adjacent to the road.

In recent years, His Majesty's Government of Nepal has established a policy where forest areas are being transferred as communal forests owned and governed by community members (Pardo, 1993). The local VDC (Shaktikhor) is in the process of convincing the DFO to transfer ownership of these forests to these communities. To convince the DFO that their interest is genuine, the VDC has established one additional forest rule—that VDC permission must be obtained before any harvesting of live timber trees (including *Shorea robusta*) is undertaken. To monitor and enforce this rule, the VDC expects villagers in the community to report any violations they see. Villagers report that this rule is rarely, if ever, followed. No conflicts between villagers over rule enforcement has been reported. In addition, we witnessed fresh evidence of timber harvesting and the villagers accompanying us exhibited little concern over the infraction.

Thus, in regard to formal institutions in the area, my conclusion is that while rules do exist and are understood by villagers, they lack adequate enforcement. Live *Shorea robusta* are essentially open access species in all forests of the area (IFRI, 1994).

In addition to these formal rules that govern these forests, there exists one unwritten, *de facto* rule or what some might refer to as a social norm. Some villagers of lower social status (caste) are not permitted to harvest in the Sugabhanjyang Forest (see Map 5.1). Villagers of higher caste live in settlements closer to the western Sugabhanjyang Forest (north-west side of Map 5.1). The people living in villages adjacent to the Latauli Forest (north-east side of Map 5.1) are primarily of a lower social caste. The higher castes on the western side of the site report that they frequently harvest from *both* the western Sugabhanjyang and eastern Latauli Forests.

The lower caste villagers however, who reside on the eastern Latauli side, report that they only forage in the Latauli Forest and never in the Sugabhanjyang Forest. While no conflicts were reported over infringements of this unwritten rule, social pressures from high-caste villages adjacent to the Sugabhanjyang Forest appear to keep these lower caste people out of this forest. This suggests that the Latauli side may be subject to more harvesting pressure than the Sugabhanjyang Forest.

The location variables described earlier—the X, Y coordinates—operationalize this social relationship. If the Latauli side is subject to greater harvesting due to foraging behavior in response to this understood rule, these location variables will reflect that influence. No other institutional arrangements exist in regard to forest harvesting in the Shaktikhor area.[13] Figure 5.1 summarizes these theoretical influences described in this section.

Number of Individuals of a Species in a Forest Plot = F (Abiotic stresses, Biotic stresses, Human stresses)

<u>Abiotic stresses:</u>

- Slope steepness
- Slope aspect
- Elevation of the plot
- Soil type/condition
- Other natural disturbances

<u>Biotic stresses:</u>

- Existence of competitor trees
- Existence of neighboring trees of the same species
- Animal grazing (wild or domesticated) patterns

<u>Human stresses:</u>

- Ease of access to plot (plot location)
- Property rights and species rules-in-use
- Monitoring practices
- Sanctioning practices

Figure 5.1: The species density model

[13] *Future studies that undertake a similar analytic method could easily establish variables to capture other institutional differences in forest plots. For example, if forest management units exist within the forest—areas within which harvesting of particular species are prohibited—a dummy independent variable could be specified to designate plots subject to this regulation.*

Statistical methods and results

In this section, I apply multiple regression estimation to the model shown in Figure 5.1. Traditional Ordinary Least Squares (OLS) regression assumes the underlying distribution of the dependent variable to be a normal, bell-shaped curve. Ludwig and Reynolds (1988) state that a normal distribution assumption is often not correct when counts of biological phenomena are utilized. King (1989) argues that maximum likelihood estimation (MLE) is a better approach, for it allows the researcher to specify both the distribution of the dependent variable and the relationship independent variables have with the dependent variable (referred to as the "functional form" or the model).[14]

MLE assumption 1: Identification of the natural distribution of the Shorea robusta species using a reference forest

The first assumption required for MLE is the identification of the most theoretically appropriate distribution of the dependent variable. This distributional flexibility of MLE avoids residual violation problems that traditional OLS estimation encounters. The dependent variable—the number of *Shorea robusta* species in a plot—is an event-count variable.[15] MLE requires the identification of the distribution of this event-count variable, and our investigation requires that the distribution be in a setting that is relatively undisturbed by human activities.

Counts of biological species usually follow one of three types of spatial arrangements: random, clustered, or uniform (Ludwig and Reynolds, 1988). In the case of a random dispersal of species, each plot has an equal chance of hosting a *Shorea robusta* individual, resulting in a frequency distribution that is normally distributed (centered around the mean). In such random patterns, the variance will be very close to the mean in value. The second pattern, a clustered pattern, is commonly found in biological studies and follows a negative binomial distribution. Clustering will result in a large number of plots where no *Shorea robusta* individuals are identified. The variance in a clustering pattern will be greater than the mean. Finally, the third pattern often identified is a uniform pattern where almost every plot exhibits the

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[14] *King (1990) also argues that with the computational power available in today's personal computers, researchers should now move to more sophisticated regression models that are more true to our theoretical understanding of the real world instead of using traditional techniques that were developed for computational simplicity. In addition, models that violate the OLS assumption of normality force the researcher to implement statistical tricks to ensure that the residuals behave properly. This research avoids having to use statistical tricks by investigating and specifying the correct distributional assumption and then modeling it using MLE.*

[15] *For a discussion of maximum likelihood event count models, see King (1989).*

same number of *Shorea robusta* individuals. In these spatial patterns, the variance will be less than the mean (Ludwig and Reynolds, 1988).

A "reference forest" was used to identify the natural distribution of the *Shorea robusta* species.[16] A reference forest is a forest that (1) is an adequate representation of the other forests of interest and (2) is generally undisturbed by human activity.

Three forests were sampled in the Shaktikhor area. The Kaswang Forest (found in the southern area of Map 5.1) satisfies the above two conditions. First, it is an adequate representation of the other two forests for they all are identified as *Shorea robusta* climax forests. While their general slope aspects do vary slightly, they all contain significant *Shorea robusta* populations. Second, the Kaswang Forest appears to be the one that exhibits the least exposure to human foraging.

Four reasons, based on IFRI (1994) findings, support the above conclusion that Kaswang is subject to minimal human foraging. First, the forest's location in relation to the villages in the area minimizes its use. For much of the year, high and strong flowing waters of the Kair River cut off the Kaswang Forest from the settlements. Even in the dry season, the river can be quite difficult to cross. Second, only about half of the villages report any harvesting of any species in the Kaswang Forest. In addition, the villagers harvesting from Kaswang report that they utilize it only as a secondary source of forest products. The other two forests supply their primary needs. Third, no evidence in discussions with villagers reveals any past dramatic change (e.g., fire, mass clear-cutting, etc.) in any of the three forests. Therefore, Kaswang has not been subject to a major catastrophe. Fourth, an examination of importance values of *Shorea robusta* trees and saplings between the three forests (Table 5.1) reveals that overall, the dominance, density, and frequency of the *Shorea robusta* species is higher in Kaswang than in the other two forests. This suggests it is under much less harvesting pressure than the other two. For these reasons, I utilize the 31 forest plots sampled in the Kaswang Forest separately as the reference forest to determine a natural distribution of *Shorea robusta*.

The variance-to-mean ratio or index of dispersion test (Ludwig and Reynolds, 1988) identifies the natural distribution of the *Shorea robusta* count for the Kaswang Forest (Table 5.2). The value for the Chi-squared statistic (df 30) is larger than the critical value at the .01 probability level, implying that *Shorea robusta* in natural settings follows a clumped pattern (variance is greater than the mean). This suggests that the dependent variable, the number of *Shorea robusta* species per plot,

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[16] *Literature describing the natural distribution of the Shorea robusta species was not available.*

follows a negative binomial distribution in an undisturbed setting (Ludwig and Reynolds, 1988: 24). Accordingly, a negative binomial is the appropriate distributional assumption for maximum likelihood estimation for this analysis.

Table 5.1: Importance values of *Shorea robusta* species in the Sugabhanjyang, Latauli, and Kaswang forests

	Sugabhanjyang	Latauli	Kaswang (Reference Forest)
Shorea robusta Trees	.2725	.1937	.4912
Shorea robusta Saplings	.0446	.0589	.2768

Table 5.2: Chi-square test of the index of dispersion of *Shorea robusta* species in the Kaswang forest

Average Number of Individuals per Plot	5.968
Number of Plots	31
Variance	12.644
Index of Dispersion (variance/mean ratio)	2.119
X^2 statistic [$X^2 = ID(N-1)$]	63.562*

*p < .01

MLE assumption 2: Identifying the model's correct functional form

The second assumption MLE requires is the specification of the model's functional form. This requires the researcher to specify relationships (e.g., linear or nonlinear) between the dependent variable and each independent variable. An assumption of strict linearity is reasonable for specifying the relationships in Figure 5.1. There is no theoretical justification for the inclusion of exponential components. With the two assumptions for MLE regression specified, a negative binomial maximum likelihood was estimated.

Statistical results

Maximum Likelihood Estimation: The results of the MLE are presented in Table 5.3. Caution is required when interpreting the regression coefficients. Since they are a result of a negative binomial regression, they cannot be interpreted in the same manner as coefficients would be if they were produced by an OLS regression. One of the most intuitive ways of interpreting these results is by creating the incident rate ratio (IRR). IRRs can be easily interpreted as a percentage of growth or decline in the dependent variable due to a one-unit change in the independent variable, holding all else constant.

The steepness of the slope is found to have a slight negative influence on the existence of *Shorea robusta* species. Holding everything else constant, a one-degree increase in the steepness of the plot will result in approximately a three (1-IRR) percent decrease in the number of *Shorea robusta* trees. This makes intuitive sense. The larger the angle of the forest plot, the more difficult it would be for trees to develop a strong foundation. The slight influence of slope, however, is not surprising. Treks through these forests revealed very steep slopes exhibiting an abundance of vegetation. During the field visit, many species, *Shorea robusta* being one, appeared to be quite capable of establishing a foundation regardless of the steepness of the slope.

The orientation of the slope (slope aspect) is found to be weakly statistically significant. While this does suggest that *Shorea robusta* does have aspect preferences, the statistical weakness of the test is not unexpected. These forests are *Shorea robusta* dominated climax forests and the species is found in all types of terrain facing all types of directions.

Only one soil variable, the depth of the humus layer, was found to have any statistically significant explanatory relationship with the existence of *Shorea robusta* trees. This may reflect some problem in the soil data collected in this site. The soil analysis was conducted without a soil color chart. While the same people collected all of the soil data, the ability to discern soil color or texture accurately may have been lacking. The other possibility is that because *Shorea robusta* is in fact the climax species of these forests, it may be robust in terms of its ability to grow in a variety of soils. The depth of the humus layer may be significant because of its relationship to the *Shorea robusta* trees itself. The humus layer reflects, in part, tree leaf litter, and therefore should be correlated with the existence of trees.

The existence of competing tree biomass is negatively related to the existence of *Shorea robusta* trees in the plot and found to be highly statistically significant. The coefficient is, however, quite small. This reflects the measure used for competing biomass—the sum of the DBH in centimeters. A one-centimeter increase in competing tree DBH results in a less than one percent decline in the number of *Shorea robusta* species. This makes intuitive sense: the existence of large competing trees in a micro eco-system will produce an area not receptive to *Shorea robusta* growth.

Table 5.3: Negative binomial coefficients for number of *Shorea robusta* trees in forest plots

Independent Variables	Coefficients	IRR
Slope Steepness	-.0287*** (.010)	.9716
Slope Aspect	.1610* (.092)	1.175
Elevation	.0043*** (.001)	1.004
Humus Layer Depth	-.3559*** (.126)	.7005
A and B Horizon Depth	-.0086 (.029)	.9914
A and B Horizon Color	.059 (.068)	1.061
A Horizon Texture	-.1736 (.179)	.8406
Competing Tree Biomass	-.0044*** (.001)	.9956
# of *Shorea robusta* Neighbors	-.1526*** (.056)	.8584
Signs of Livestock Grazing	-.4884 (.404)	.6136
X Coordinate	-.0008*** (.0002)	.9991
Y Coordinate	.0006 (.0005)	1.0006
Intercept	.8062 (1.35)	—

Negative Binomial log-likelihood: -103.61 **n = 66**

***p < .01 **p < .05 *p < .10

The number of *Shorea robusta* trees in the nearest-neighbor plot was also found to be influential at the .01 level. At first glance, the negative sign on the coefficient is surprising. The IRR reports that an increase in one *Shorea robusta* tree in the closest neighboring forest plot will result in nearly 15 percent decline in the number of *Shorea robusta* trees in the plot of interest. The influence could be explained by the natural strategy *Shorea robusta* trees take to replicate. The helicopter-like wings attached to the seed have developed so that they fly a good distance away from the parent tree. Winds take seeds away in a particular direction and several may take hold resulting in the natural clumped pattern exhibited by the Kaswang Forest.

Finally, of the other two location parameters in the model, the X and Y GIS coordinates, only X was found to be significant. The interpretation of this requires a review of Map 5.1. The X and Y coordinates reflect locations on this map, or grid. The Y coordinates follow the north-south axis, and the X coordinates follow the east-west axis. The origin is located in the center of the map—somewhere near the river convergence. The negative sign on the X coefficient suggests that as we move in an easterly direction, the trend in the number of *Shorea robusta* individuals decline. While the coefficient is small, it emerges as the most significant variable in the model.

Discussion

Let us now return to the two research questions presented in the Introduction. The first question asks whether the spatial pattern of *Shorea robusta* differs in the two forests from what we found in the relatively undisturbed setting of the Kaswang Forest. The evidence provided in Table 5.2 strongly suggests that the spatial pattern of *Shorea robusta* within these two forests *is* different: the species does not follow a clumped pattern. This suggests that over space, *Shorea robusta* exhibits depletion in both the Sugabhanjyang and Latauli Forests.

The MLE regression location variables also support this conclusion. If the *Shorea robusta* individuals in these two forests follow a clustered or the negative binomial distribution as they should in an undisturbed setting, these location variables should not be significant predictors in the model. The distributional assumption used by MLE should account for the expected clumping pattern. Since both the X coordinate and elevation are found to be significant—and are, in fact, the two most highly significant variables in the model—they suggest that the spatial distribution of the *Shorea robusta* species in these forests follow a pattern different from what is expected in a natural setting. In short, the answer to research question one is: the data demonstrate that the natural spatial pattern of *Shorea robusta* has been disturbed in these two forests.

To answer research question two—what accounts for the distributional difference—I again turn to the location coefficients of the model. The elevation coefficient is highly significant and positive. This means that as one moves higher in elevation, the number of *Shorea robusta* species increase. What is interesting about this finding is that *Shorea robusta* are found in the lowest elevations in Nepal up to a maximum height of 1200 meters (Storrs and Storrs, 1990). The highest elevation in this study was approximately 800 meters. For this reason, in an undisturbed setting, I would not expect elevation to have any influence in the growth of this species after controlling for the clumped distribution of the species. I confirmed this expectation by running a similar regression on the data from the reference Kaswang Forest. In that instance, elevation is not found to be significant. Yet for the Sugabhanjyang and Latauli data, elevation is the second most significant influential variable in the model. This finding appears to support optimal foraging theory. Harvesting timber and carrying it back home from high elevations located far from the villages is both time-consuming and labor-intensive. The elevation coefficient suggests that villagers prefer to harvest in plot areas that are found in lower elevations and closer to their homes.

The significance of the X coordinate is by far the most interesting finding. The negative coefficient of the X coordinate suggests that the trend in the count of *Shorea robusta* species diminishes as one moves east from the center of Map 5.1. The Latauli forest plots exhibit fewer numbers of the species. A number of alternative explanations exist that could account for this finding.

The first possible explanation for Latauli's depletion is that population in the Latauli area is greater than in the Sugabhanjyang area. However, IFRI data on village population cross-checked with 1990 census data both reveal that the population is greater in the western villages—the villages adjacent to Sugabhanjyang. The population data alone would suggest that Sugabhanjyang's Forest should exhibit less quantities of *Shorea robusta*—but it doesn't. Hence, a population explanation isn't supported.

The second possible explanation for the trend of depletion towards the Latauli Forest is an optimal foraging argument: that the Latauli plots are closer to the villages than Sugabhanjyang plots and therefore are more depleted. Just a glance at Map 5.1 proves this argument to be false. If anything, some Latauli plots are farther from villages.

The most convincing explanation for the Latauli depletion finding returns us to our earlier discussion of DFO monitoring and social norms that exist in the Shaktikhor area. My earlier description on DFO rules revealed that three formal rules exist that are applicable to all villagers in the region. However, the monitoring mechanisms are much stronger in the west along the road that follows the river just below and on the same side as the Sugabhanjyang Forest. This monitoring pressure in the west establishes an added incentive to harvest away from the road in the eastern Latauli Forest.

In addition, discussions with villagers on harvesting location preferences reveal the existence of social norms that also influence harvesting behavior. The villagers from lower castes, who reside in villages in the east, report that they only harvest in the nearby Latauli Forest. The higher-caste people however, living in the villages on the western side of Map 5.1, report that they harvest from both their nearby Sugabhanjyang Forest as well as the more distant Latauli Forest. These higher-caste villagers actually break the first formal DFO rule when they forage in Latauli, for they cross a VDC boundary. The poorer villagers residing in the eastern side of Map 5.1 could make a legitimate complaint to the DFO if they desired, yet they do not. No conflicts have been reported, and both groups confirm these harvesting practices. Consequently, the best explanation for the diminishing trend of *Shorea robusta* towards Latauli is the combination of harvesting altered by more effective monitoring in the western side of Map 5.1 coupled with existing social norms between communities of differing caste structures.

Conclusion

While ecologists and biologists have made tremendous advances in the study of the spatial distribution of various plant species, to my knowledge, this is the first analysis of its kind that applies recent technological advances of GPS, GIS, and maximum likelihood estimation to this effort. The inclusion of a spatial influential variable in the regression model provides an alternative methodology for identifying early forest depletion when longitudinal data is nonexistent. The findings support my earlier claim that a plot level of analysis may reveal findings that would not be discovered at the forest level of analysis.

This study may also be the first of its kind to apply an institutional analysis to the study of the distribution of a particular species over space. It provides a new technique for researchers utilizing IFRI data to identify the influence of institutions on foraging behavior. While the study site was limited in terms of the institutional arrangements that could be modeled, this effort does show that a spatial analysis of IFRI forest plot data can be quite revealing in identifying how humans react to both written and unwritten rules and social norms. The location information in the regression model provides evidence that social norms produce resource inequities.

Let me conclude with three lessons to improve the methods utilized in this research. First, the researcher would be wise to document carefully location variables such as the distance of plots to nearby trails. This data, which was not collected in this study, may provide additional explanatory power in the model. Optimal foraging theory suggests that plots located closer to trails will be subject to greater harvesting if effective institutions have not been established to prohibit this activity. This additional information, added to the model, could assist us in understanding the influence of various institutional arrangements and would capture another spatial component of optimal foraging theory. Second, plot sampling should take into account the location of trails. In this study, the plots collected may have been biased toward a depleted state due to their close proximity to trails. An effective sampling strategy should select plots that are both near and distant from forest trails and document this distance accurately. Third, for quality regression results, plot locations should be meticulously recorded through the use of topographic maps and a carefully recorded traverse through the forest. If available GPS recordings are taken, these points should be differentially corrected to ensure their accuracy.[17] Location errors inherent in one GPS receiver acting alone, or in careless recording on topographic maps, could cause significant problems for this kind of analysis.

[17] *For a brief discussion on GPS accuracy, see August et al. (1994).*

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Chapter 6

The Lack of Institutional Supply: Why a Strong Local Community in Western Ecuador Fails to Protect its Forest

C. Dustin Becker and Clark C. Gibson

Introduction

Given the disappointing results of natural resource conservation policy in developing countries over the last three decades, scholars and practitioners have shifted their focus away from state-centered policies towards solutions at the local level (Ostrom, 1990; Hecht and Cockburn, 1990; Marks, 1984; Blockhus et al., 1992; Poffenberger, 1990; Bromley et al., 1992; McCay and Acheson, 1987; FAO, 1990; Ascher, 1995). While these authors offer different lists of the conditions believed necessary for successful resource management by local people, most analyses include three fundamental requirements. First, individuals from local communities must highly value a natural resource to have the incentive to manage it sustainably. Second, property rights must be devolved to those individuals who use the resource to allow them to benefit from its management. Third, these individuals at the local level must also have the ability to create microinstitutions to regulate the use of the resource. Although various scholars and practitioners may add other conditions they see as important, most agree that some form of these three—locals' valuation, ownership, and institutions—are central to successful natural resource management.

In the *comuna* of Loma Alta in western Ecuador, these three conditions initially appear to be met. Residents of Loma Alta consider their 1,650 hectares of tropical moist forest important for its products such as timber to sell, building materials, and game. Comuna members enjoy well-defined and secure property rights to their land, allowing individuals to make capital improvements to their plots, rent their lands to others, and transfer their holdings to family members through inheritance. Finally, Loma Alta boasts a strong history of crafting local institutions to deal with community concerns. The community has successfully crafted institutional arrangements dealing with the provision of goods such as schools, health clinics, and wells, as well as electoral institutions that allow each comuna member a voice in the administrative proceedings and the selection of their leaders. The central government has recognized the comuna as the legitimate form of local government since the Law of the Comunas passed in 1936.

Despite their positive valuation of the tropical forest, their relatively secure property rights to land, and their rich history of crafting microinstitutions, the members of the Loma Alta community have not created microinstitutions to regulate the use of their tropical forest. Few local rules exist about the removal of forest products, the cutting of timber, the hunting of game, or the clearing of land. Although parts of the forest appear to be relatively healthy, over a third of the forest has been decimated by the exploitation of timber and the expansion of agricultural and pasture lands.

Some of the explanation for the forest's depletion can be found in the type of property rights the comuna has allocated to different parts of the forest. The one-third that is most exploited is the comuna's "forest reserve," which has not been allocated to individual comuna members. This section's overuse conforms to outcomes predicted by well-known theories regarding open-access, common-pool resources. The other two-thirds of the comuna's forest has been allocated, and is in relatively better condition. And, yet, property rights alone do not explain the spatial variance of the forest's condition within the allocated areas. Some individuals with plots in the forest appear to cut selectively their plots, generating stands of secondary growth. Others, however, pursue plantation agriculture or cattle-raising, motivating them to clear the forest to expand their holdings. The result of this complex pattern of property rights and activities is a starkly patchy forest: nearly treeless areas are contiguous with sections of dense secondary growth containing a wide diversity of species, some endemic to the region.

This chapter seeks to explain why the members of Loma Alta have not created microinstitutions to protect and manage their forest. Unlike so many local communities in the developing world, Loma Alta does possess those institutional features considered necessary for the successful conservation of natural resources; yet it, too, has failed to create rules to protect its forest. We argue that the explanation for this failure of institutional supply requires an understanding of the forest's many user groups, the forest products they value, and their property rights to these products. We find that the pattern of incentives confronting Loma Alta's multiple forest users discourages the creation of institutions to govern forest use, despite the comuna's strong institutional assets. Comuna members prize the immediate exploitation of certain forest products and do not recognize the critical public goods produced by the forest, especially watershed and climatic services. Only when comuna members substantially value the benefits of these public goods and overcome the collective-action problem of institutional supply will a local-level institution regulating Loma Alta's Forest be created.

We collected our data using the methods of the International Forestry Resources and Institutions (IFRI) research program. The IFRI program is a pioneering effort to study forests and their use by collecting and analyzing both social and biological data at the micro level. A central hypothesis of this program is that institutions significantly affect the use and condition of forests (see Appendix I to this volume).

This chapter has six parts. In the first part, we briefly review some of the core assertions made by scholars and practitioners regarding the supply of micro-institutions that govern natural resource use at the local level. The next part introduces the comuna of Loma Alta, reviewing its institutional history, decision-making structures, and property-rights institutions. In the third part, we present the biological data collected in the Loma Alta Forest. These data indicate that much of the forest is in relatively good shape, while some parts exhibit tremendous overuse. In an attempt to explain the variation of forest condition, we investigate the users of the forest, their use-patterns, and the rules that influence their behavior in the fourth part. We show that the groups that comprise the greatest contemporary threats to the forest's condition are comuna members and outsiders using unallocated land, and members who convert forest land to plantation agriculture. We present an analysis of these use-patterns in the next part, attempting to derive an explanation for the lack of institutional supply from the incentives of user groups. Creating institutions to manage natural resources is costly; such costs are increased by the multiuser, multiproduct nature of forests. In Loma Alta, individuals do not value the public goods generated by the forest, and the different streams of private benefits that accrue to individuals are not sufficient to motivate them to create rules to regulate forest use. In fact, the three most important user groups in Loma Alta—farmers, woodcutters, and outsiders—would experience significant losses in the short run if an institution restricted their use of the forest. We conclude the chapter by discussing how the pattern of user group behavior may be changed in an effort to prevent the Loma Alta Forest from being completely depleted.

Natural resource management and the local level

A growing number of scholars and practitioners recognize the crucial role played by local people in natural resource management (Ostrom, 1990; Hecht and

Cockburn, 1990; Marks, 1984; Blockhus et al., 1992; Poffenberger, 1990; Bromley et al., 1992; McCay and Acheson, 1987; FAO, 1990; Ascher, 1995; Agrawal, this volume). They argue that policies emanating from central governments generally give local communities few rights over the natural resources with which they live. Without legal claims to the stock or flow of benefits from these resources, locals have little to gain from protecting them or using them sustainably. Such conditions generate incentive structures that encourage individuals to "poach" natural resources, and discourage them from constructing or maintaining rules or institutions at the local level to regulate their resource use (Gibson and Marks, 1995). Because many governments lack the resources necessary to monitor and enforce their natural resource policies, this pattern of incentives often results in overexploited resources (Becker, Banana, and Gombya-Ssembajjwe, 1995).

Critics of exclusionary government policies assert that sustainable policies must include those individuals that live with the natural resource. Many conditions for successful local-level management have been put forward. Most writers, however, include three requirements: (1) locals must value the resource, (2) they must possess some property rights to the resource, and (3) they must construct local-level institutions that control the use of the resource (Bromley et al., 1992; McCay and Acheson, 1987; Ostrom, 1990; McKean, this volume). The reason for the first condition is clear—unless locals place sufficient value on the resource, they have no reason to incur costs to protect or conserve it. While this condition appears trivial, many scholars and public policymakers routinely ignore it, and think that individuals will somehow conserve resources for some national or global good. Most practitioners, however, have come to realize that people must perceive some individual net gains from managing a resource to agree to constrain their short-term use of it.

The second condition of successful local management highlights the importance of property-rights arrangements. While debate surrounds exactly which bundle of property rights is most efficient for the sustainable use of natural resources, considerable agreement exists that locals should have some stake in the resource relating to access, use, and the exclusion of others (McKean, this volume; Demsetz, 1967; Libecap, 1989; North, 1990;Ascher, 1995). Such rights allow locals to control the benefits and costs of a resource, and thus may offer a reason for people to manage it for the long term (Schlager and Ostrom, 1993).

Finally, scholars and practitioners often assert the need for local-level institutions in natural resource management schemes (Ostrom, 1990; Marks, 1984; Bromley et al., 1992). When compared to central government institutions, local institutional arrangements are considered better at providing, *inter alia*, rules related to access, harvesting, and management; fora that can respond to conflict quickly and cheaply; and monitoring and sanctioning methods that are efficacious. Further, locals are more likely to create such institutions if their community enjoys a history of rule-making together, since the costs, benefits, and techniques of institution building will be well-known to the participants.

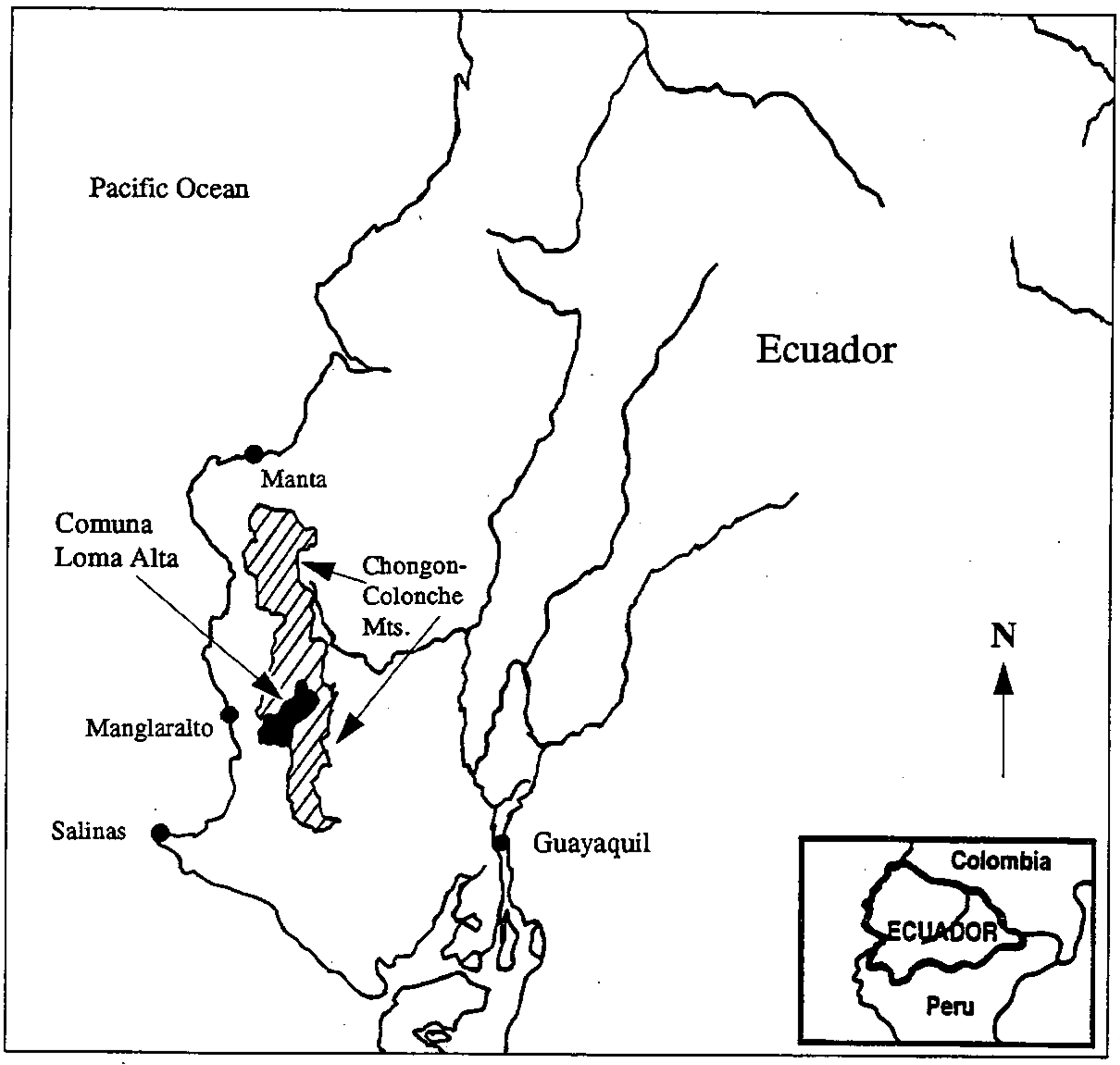
These three general conditions are by no means exhaustive of the requirements authors assert are important to the construction of successful natural resource management institutions. Others include: sufficiently small boundaries for the resource to be managed, a relatively small number of users, users who live near to the resource, users who are not strongly divided by cultural or ethnic differences, and users who perceive the rights system to be relatively fair. The case of the Loma Alta comuna in western Ecuador not only meets the three general criteria presented but fulfills almost all of the preconditions that scholars and practitioners consider important.

The social and physical assets of Loma Alta

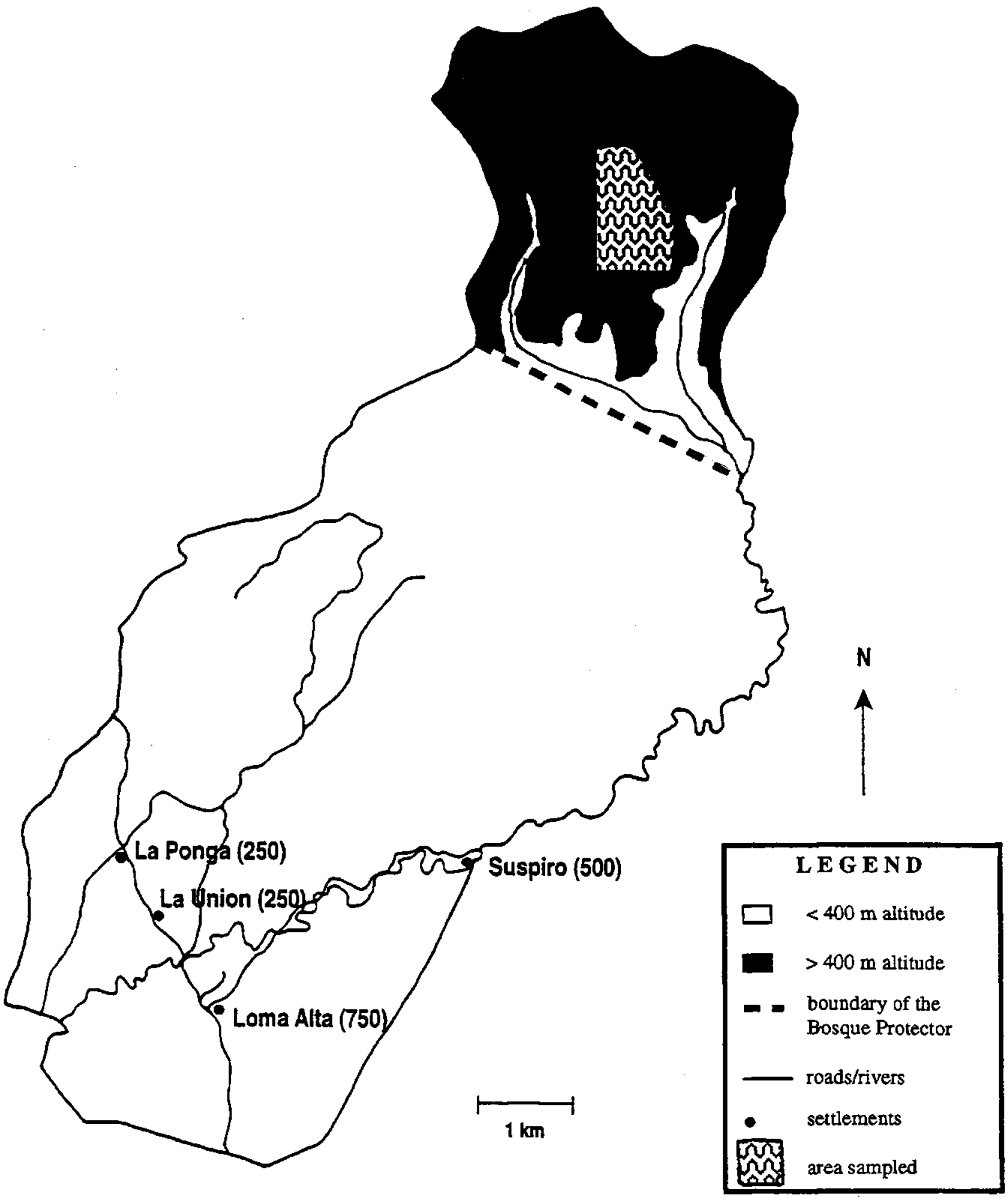
Institutions

The Loma Alta comuna is a community of approximately 2,000 people who share property rights to 6,842 hectares of land in western Ecuador (see Map 6.1). The comuna members are distributed among four settlements—Loma Alta, La Union, La Ponga, and El Suspiro (see Map 6.2). Current residents recount how the settlements were established at the turn of the century by five families moving from more populated towns of the east and southwest who were seeking better opportunities for themselves; they especially sought to acquire land for agriculture. There were small numbers of peoples indigenous to the region, who had established land tenure patterns roughly based on the watersheds of the Chongon Colonche mountain range. The newer settlements continued this centuries-old pattern, as well as the linkages with small towns on the coast to supplement their household needs. These early settlers survived through subsistence farming and selling charcoal, timber, and straw hats to townsfolk.

In response to the actions taken by several coastal municipalities who were selling large tracts of land to urban dwellers during a period of land speculation, the central government passed the Law of the Comunas in 1936. This law formalized and augmented much of the traditional land tenure arrangements already found in the area. Individuals can petition a comuna to be a member when they reach the age of 18. Members pay an annual tax that is used to provide and maintain certain public goods in the comuna (health clinic, road, etc.). Governing the comuna occurs through two institutions. The comuna chooses a *cabildo* (council) each year in democratic elections decided by majority rule. Five officers comprise the cabildo—president, vice-



Map 6.1: Western Ecuador



Map 6.2: Loma Alta comuna and its bosque protector

president, treasurer, secretary, and legal advisor—who are responsible for the comuna's daily management. The cabildo officers also chair the monthly *asamblea* (community meeting) at which all comuna members make decisions collectively through majority votes. Members are expected to attend regularly, and can be punished if they are absent from the asamblea.[1] Members also frequently serve on various comuna committees (existing committees include child care, education, sanitation, and reforestation).

The most critical power of the comuna is its control over land. The 1936 law stipulates that the comuna as a whole owns the land and can allocate it to members for their use. In Loma Alta, a member must petition the comuna for land; *asambleas* usually grant most requests for plots less than 15 hectares (although many members possess more than one plot). Several rules constrain members' rights to their land. First, the comuna allocates land with the understanding that it must be used; plots left unused are subject to confiscation by the comuna. In practice, however, the interpretation of "use" is quite broad in Loma Alta: the comuna considers renting a plot to be a bona fide use, as well as keeping a field fallow for the regeneration of trees. No current member of Loma Alta recalls an incident in which the comuna has reclaimed land previously allocated. Second, an individual cannot sell their land to an outsider without the comuna's approval (by majority vote at an asamblea). To date, no land has been sold by comuna members.[2] Third, a member cannot rent land to anyone without comuna permission. Members, however, routinely flout this rule, renting land to other members without informing the comuna. Fourth, upon a member's death, land returns to the comuna to be reallocated. If any improvement to the land had been made by the deceased member, however, the comuna is required to compensate family members at the market price of the improvement(s). In practice, this compensation clause acts to promote inheritance. Since the comuna rarely has the money to recompense family members for improvements, sons and sons-in-law invariably receive their fathers' plots. No one in Loma Alta remembers an example of property reverting to the comuna after a member's death. Still, sons and sons-in-law often make official "requests" to the comuna for their fathers' land so as ensure this inheritance.

Comuna members respect each other's land boundaries. When the comuna decides to allocate a plot, a cabildo officer (or representative appointed by an officer) will travel to the plot site with the prospective user. The official, prospective

[1] *We experienced this first-hand. We needed a small shelter to be built in Loma Alta's Forest in order to sample the flora of our random plots. When no one volunteered their forest land for the structure, an absent member's plot was chosen.*

[2] *Two nonmembers, however, do hold title to private plots as a result of pre-1936 purchases. National and local governments respect the rights of those landowners whose purchases were completed before the enactment of the 1936 Law of the Comunas.*

owner, and neighbors agree on the new boundaries, which can be either part of the natural landscape (river, ridge top, etc.) or constructed (with rocks, planted trees, etc.). This system appears to work relatively well, as comuna members and officials consider boundary disputes among comuna members to be rare. Incursions by individuals outside of the comuna, however, do occur. The most egregious example of such incursion occurs in the comuna's tropical premontane humid forest, which we discuss below.

Several consequences flow from this system of property rights to land. First, members hold considerable rights to their property: they are not restricted in their use of land, face few impediments when renting it, and can inherit land from family members. While they cannot sell their plots outright, they possess enough incentive to make considerable capital investments in the land, as evidenced by the number of houses built, wells sunk, fences constructed, trees planted, and irrigation trenches dug in Loma Alta. Thus, although the entire comuna system possesses some "communal" attributes, those allocated land within Loma Alta enjoy strong private rights to their property. As we will see below, these rights critically affect the use and condition of Loma Alta's Forest.

Loma Alta's "protective forest"

In 1986, Loma Alta sought assistance from Ecuador's central government to have its upland territory protected from encroachments made by members of a neighboring comuna. The area lies approximately 8 kilometers from El Suspiro, the nearest settlement, requiring three to four hours of travel time to reach (local residents travel on foot, mule, and horse). By 1987, the Ministry of Agriculture had demarcated the northern 1650 ha. of the comuna and declared it a *Bosque Protector* ("Protective Forest"; hereafter "the forest") (see Map 6.2).[3]

The forest exists on steep hills ranging in altitude from 200 m to 830 m. Along that gradient, vegetation changes from predominately tropical dry forest to a premontane humid "fog forest."[4] Much of the moisture required to support the moist forest tree species comes from the *garua* or fog season that lasts from July through November. Fog interception supports trees typically found in wetter regions of Ecuador and enables abundant populations of epiphytes to grow in the forest.[5]

Ecologists divide the forest into two ecological zones. Those parts above 400 m are dominated by premontane humid forest (Fundacion Natura, 1992).

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[3] *"Protective" refers to the forest's role in protecting the watershed.*

[4] *Because the Loma Alta Forest is not above 2000 meters, it cannot be defined as a typical cloud forest, although fog forests share much of the same characteristics (see Parker and Carr, 1992). See also the work of Dodson and Gentry (1991) on the forest resources of western Ecuador.*

At elevations below 400 m, the forest shifts to dry forest, which contains more deciduous species. The transition between these two ecological zones is not abrupt. While the moisture of the forest increases from lower to higher elevations, the type of crops planted by Loma Alta's farmers does not vary much at elevations above 300 m—which includes almost all of the forest lands except river valleys.

For this analysis, another useful division of the forest follows the different property rights assigned to its parts by the comuna. Much of the northwest portion of the forest has not been allocated to individual comuna members, who call this area the *comuna reserve.* In this area, which we estimate to cover approximately 600 hectares, all comuna members may extract resources.[6] In the remaining 1,050 hectares of the forest, the comuna has allocated plots to individuals, who enjoy the bundle of rights discussed earlier.

The condition of the forest can be partly explained by these two different sets of property rights. The open-access nature of the comuna reserve has led to its severe degradation. An aerial photograph taken in August 1986 shows deforestation along the entire northern and western edge of the comuna reserve. At that time, about 50 hectares had been converted to pasture, and another 50 hectares had been cleared and cultivated. By August 1995, the pasture in the comuna reserve had been extended to cover approximately 350 hectares, and extensive timber harvesting had taken place on the rest. We estimate that as a whole, users' intensive exploitation of the comuna reserve has led to the removal of 75% of the area's forest cover.

In contrast, in the part of the forest that has been allocated to individuals, the forest is less depleted overall. However, the allocated areas display considerable variation over forest condition both within and between parcels. Such variance results from the different types of activities that landholders pursue on their plots. Those comuna members who are engaged in agriculture value the lands of the forest because of the increased humidity in the area. These farmers are slowly intensifying agricultural practices in the forest in response to the drying trend found at lower elevations.[7] Two major stream beds provide landholders easy access to this area during the dry season, as well as water for their crops from February through March.

[5] *Such fog forests are of intense interest for those concerned with the conservation of biological diversity, since they boast endemic species and the conditions favorable for future speciation (Parker and Carr, 1992). Because the Chongon Colonche range is adjacent to, but geographically separated from, the Andes, its evolutionary pathways are isolated sufficiently to give rise to new subspecies and species. Conservationists are currently working on strategies to maintain evolutionary processes in these areas.*

[6] *Comuna members are not clear about the borders of the area, and we were unable to survey the entire area. Further, the comuna does not possess a map of the reserve. Hence, the boundaries shown on Map 6.2 are our best estimate given discussions with comuna members, but lacking the groundtruthing that we plan to undertake in the next phase of our research in the area.*

Most of the comuna members with plots in the forest have responded to these favorable conditions by planting *paja toquilla* (Carludovica palmate), the leaves of which are sold to the makers of panama hats. Farmers' holdings vary from approximately 5-12 hectares, with 1-3 hectares established as paja toquilla plantations. On these plantations, the forest is cleared of forest trees, burned, and planted with paja seedlings. In some of the remaining areas of their holdings, farmers plant crops such as citrus trees, plantain, tagua, banana, and coffee.[8] In between and among these crops can be found stands of secondary growth forest, although we estimate that only a handful of trees with a diameter at breast height (DBH) of more than 25 cm remain.

Woodcutters also own plots within the forest's boundaries, and it was on these plots that we conducted our most in-depth biological analyses.[9] Interestingly, the condition of the forest on woodcutters' plots is generally quite good. In 30 plots of 300 m^2 each, randomly distributed over 200 hectares of landholdings, only two plots had any recent (within the last 5 years) evidence of timber harvesting.[10] Additionally, we found no cases of current conversion to agriculture or pasture in these forest landholdings.

For some timber species in this part of the forest, it is obvious that sustainable harvesting has not been the norm, and the resource has been depleted. For example, only 4 of the 493 trees measured were the extremely valuable guayacan (*Tabebuia chrysantha*), and no saplings or seedlings of this species were recorded. Still, per hectare, our sampling found 30 preferred timber trees with diameters above 25 cm, and regeneration was occurring for many of these. Using this number as an estimator for the entire 200 hectares sampled in our study, about 5962 timber trees of harvestable size currently exist, or 5.7% of the trees (523 trees per ha. x 200 ha. = 104,600) we estimate to remain.

The size class distribution and the density of the current fog forest stand reflects the harvest of older, larger trees in the past. The mean DBH of trees with a DBH above 10 cm is only 21.8 ± 16.34 cm (N=492 trees), indicating a young or secondary forest structure.[11] Primary tropical forests are surprisingly consistent in propor-

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[7] The intensification of agriculture is not the result of population increases since the number of comuna members has remained fairly constant over the last two decades.

[8] Coffee was formerly the most valuable crop in the region before drought and disease destroyed most plants in the area.

[9] Because of the short duration of this pilot study, we sampled the areas of the forest considered the healthiest by comuna residents, forestry officials, and nongovernmental organization officials.

[10] We sampled the plant communities in the fog forest to determine what biological influences both past and present uses of forest have had, and to establish a baseline for monitoring the forest in the future. In this chapter, we focus on the condition of woody vegetation: trees, saplings, and seedlings in the forest. For this study, trees were defined as having a DBH >= 10 cm; samplings >= 2.5 cm but < 10 cm; and seedlings < 2.5 cm or a height of less than one meter.

tions of stems of a particular size (age) (Richards, 1975). As shown in Table 6.1, our data from Loma Alta's Forest deviates from the primary forest pattern in an expected way. In the secondary forest of Loma Alta, there are more small trees in the 10-20 cm category, and fewer large, older trees, explaining the low average stem diameter.

Table 6.1: Tree size classes in tropical primary forests vs. Loma Alta's secondary forest (The distribution is statistically different.)

Stem Class (DBH in cm)	Primary Forest % ± S.D.*	Loma Alta %
10 - 19.9	44 ± 4	60
20 - 20.9	28 ± 2	22
30 - 30.9	18 ± 2	8
40 and above	12 ± 2	10

*** N = 7 primary forests; 3 South America, 2 Africa, 2 Asia (Richards, 1975: 230).**

The density and diversity of mature trees with DBH greater than 10 cm are shown in Table 6.2. These structural and community features are consistent with expectations for a normal regenerating secondary forest. Typical of selectively harvested forests, the Loma Alta Forest has a high number of mature stems per hectare (523), and has patchy distributions of pioneer genera such as *Cercropia*, *Inga*, and *Geonoma*. Gaps created by the harvesting of the large timber trees are being filled by these fast growing soft wood and palm species. Species-abundance patterns are normal for tropical second growth forests with four or five dominant species, four or five subdominants, and a long list of less common species.

These findings are hardly what one would expect if the Loma Alta community had used its entire forest as an open-access resource.[12] Neither are they consistent with what we would expect if Loma Alta had constructed institutions to manage their forest resources, purposefully maintaining the 1,650 hectares of protective forest. Rather, variation of forest cover in Loma Alta's Forest reflects the practices of different user groups operating under different sets of incentives.

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[11] One extreme outlier, a Ficus obtusifolia, was omitted from the mean and standard deviation because of the difficulty in obtaining an accurate measurement (i.e., discriminating between above-ground root system and trunk). The recorded DBH (200 cm) is nearly twice that of the next largest tree. The range of the sample is 100 cm.

[12] For example, in a recent study of a Ugandan forest characterized as open access, over 50% of the plots had evidence of charcoal making, timber harvesting, or commercial firewood cutting (Becker, Banana, and Gombya-Ssembajjwe, 1995).

Table 6.2: Diversity and density of trees (DBH > 10 cm) in Loma Alta's fog forest, Ecuador

Taxonomic Information (local names)	Stems per hectare	Est. % of Trees
I. Preferred Timber	**80**	**15.3**
Beilschmiedia spp. (Maria)	36	6.8
Ocotea spp. (jigua)	20	3.8
Cordia spp. (tutumbe)	10	1.9
Guarea spp. (chicoria)	8	1.5
Tabebuia chrysantha (guayacan)	4	.8
spp.? (figueroa, cedro)	2	.4
II. Taxon with more than 5 stems/ha	**345**	**66.0**
Gleospermum sp. (guayaba de monte)	76	14.5
Quararibea grandifolia (molinillo)	65	12.4
sp? (morocho)	32	6.1
Geonoma sp. (palma)	25	4.8
Cecropia spp.	23	4.5
Chrysophyllum sp. (mangillo)	19	3.6
Grias sp. (huevo de chivo)	16	3.0
Mapuira sp. (camaron)	15	2.8
Inga spp. (guaba de bejuco)	13	2.5
Pentagonia sp. (palo de murcielago)	13	2.5
sp? (pepito colorado)	10	1.9
Turpinia occidentalis	8	1.5
Ficus spp. (mono, cauchillo)	8	1.5
Rheedia sp. (amarillo)	6	1.2
sp? (miguelillo)	6	1.2
Phylotacea dioica (yuca de raton)	5	.9
Randia sp. (canafito)	5	.9
III. Taxon with less than 5 stems/ha	**54**	**10.3**
Prunus subcorymbosa (mamecillo)	4	
Sapium utile	4	
Zanthoxylum sp.	4	
Mauria sp. (mulato)	4	
Mollinedia sp. (cafe de monte)	4	
Pourouma sp.	4	
sp? (bijama)	3	
sp? (tabaquillo)	3	
Annona sp.	3	
Brosmium sp.	3	
Piper squamulosum	2	
sp? Anona de monte	2	
Ardisis sp.	2	
Bactris sp.	2	
Gutiferae sp.	2	
Phytelephas aequatorialis (tagua)	2	
Miconia sp.	2	
Psychotria sp.	2	
Tabernaemontana sp.	1	
Trema micrantha	1	
IV. Unidentified Trees	**44**	**8.4**

Users, user rules, and use-patterns

Different subsets of comuna and noncomuna members value the assets of their forest for different reasons. In this part, we examine the six most important user groups of Loma Alta's Forest: hunters, outsiders, wood users, commercial timber dealers, farmers, and woodcutters. Some, but not all, of the individuals of these groups overlap. The resultant pattern of users, products, and preferences helps explain the variance of the forest's current condition.

Hunters comprise one important group using Loma Alta's Forest. While populations of wild game in the forest have declined over the years, enough paca (*Agouti paca*), guatusa (*Dasyprocta punctata*), white-tailed deer (*Odocoilus virginiamus*), and red brocket deer (*Mazama americana*) exist to encourage locals to make the trek to the forest to obtain meat. Comuna members seem to prefer the taste of game to that of domesticated animals (locals raise cattle, pigs, chickens, turkeys, ducks, and goats), but the price of game meat does not reflect this as game is not significantly more expensive. A trade in game meat does exist, but it is small and localized. Hunting is clearly secondary to residents' other activities. While it provides some additional protein to diets, it is not a critical supplement.

While the comuna has not established any formal rules regarding hunting within the forest, several norms appear to be respected by the hunters. First, individuals hunt alone or in small groups rarely exceeding four people; larger hunting parties are considered inappropriate. Second, hunters dislike spending nights in the forest, and so hunting trips of more than two days rarely occur. Third, comuna members disapprove of hunting for commercial gain. Those that do hunt generally eat what they kill, only occasionally selling small, extra portions to other comuna members.

Outsiders invading the forest constitute another significant user of the comuna's forest. The most important invader is a relatively wealthy, cattle-raising family living in a neighboring comuna (Dos Mangas). The family's employees have cut down the trees and burned the scrub on approximately 400 hectares in the northern section of the comuna reserve.[13] The area cleared corresponds to several of the denuded patches evident on the 1986 aerial photograph, and our own efforts at groundtruthing discovered that the fenced pasture has been extended to an even greater area. While the comuna has made some efforts to prevent this incursion—through such means as having the forest declared protected, cutting the wire fences that the family's employees erect, attempting to use the courts, and confiscating

[13] *Three additional invaders have used land within the Loma Alta comuna, but each affects plots of less than one hectare each.*

lumber taken by the family from that plot—Loma Alta has few efficacious enforcement mechanisms to protect their comuna reserve.

A third important group, which includes most of the comuna's residents, uses the timber of the forest for construction. While some residents construct their homes and shops with concrete block or stone (especially in the town of Loma Alta, which is the most commercial settlement of the comuna), most of the people living in the settlements of El Suspiro, La Ponga, and La Union use the hardwoods and bamboo gleaned from the forest to build their homes, fences, animal pens, and small stores. Locals prize guayacan (*Tabebuia chrysantha*) for cross beams, maria (*Beilschmiedia spp.*) for stilts, and jigua (*Ocotea spp.*) for floor planking. Bamboo (*Guadua spp.*) is used for internal and external walls, and is also an important fence-building material in all four of Loma Alta's settlements.

Individuals confront several choices in their efforts to obtain wood for construction. They can contract with landholders whose plots have the desired timber. They can also travel to a neighboring comuna to either poach or contract for timber. They can travel to the comuna's reserve—where land has not been allocated to any individual—to cut trees. Finally, they can contract with a woodcutter who will, in turn, cut the timber from the unowned reserve, negotiate with a landowner, or cut from a neighboring comuna. Comuna residents believe that the vast majority of wood currently taken comes from the comuna reserve. The constant use of this open-access area has resulted in local complaints about the increasing difficulty of finding the most-desired species for home building.

Individuals involved in the commercial timber business comprise another significant group of forest users—arguably the most critical user group when considering the forest's current condition. Timber was needed to build the coastal towns in the region (e.g., La Libertad, Barcelona, Manglaralto, and Santa Elena). As a result, from 1940 through 1960, commercial timber interests cut extensively from the entire Chongon Colonche range. Loma Alta residents claim that these outsiders continued to cut in their forest to supply the towns with wood; only within the last decade has the commercial activity tapered off. Typically, outside merchants would arrive with trucks and either contract with comuna members who held land in the forest, with members who were woodcutters, or try to cut wood in areas held by the comuna as a whole to avoid payment.

Few rules appear to have limited the activities of the commercial timber industry. The comuna did make a small attempt to capture the benefits from this lucrative industry by imposing a tax on wood leaving their territory. However, since the tax was nominal and loosely enforced, it did nothing to restrain the cutting of trees. The intensity of this business has decreased noticeably with the concomitant reduction of commercially-valuable timber. Currently, only a few trucks come to Loma Alta with the intent to transport timber out of the comuna. The lack of valuable species and large trees in most of the forest is in part attributable to the extensive cutting of previous generations.

Since large-scale commercial timbering has declined, the user group comprised of the approximately 25 comuna members who have been allocated plots within the forest has the most significant effect on the condition of the Loma Alta forest.[14] Most of these landholders have cleared their plots to cultivate paja toquilla. Paja has been farmed in the area for at least the last 100 years. Its importance has grown over the past two decades due to the increasing demand for panama hats and the decline of its cash crop rivals—coffee and tagua. Comuna members have enjoyed a consistently growing demand for their paja leaves over the past generation; presently it is the most valuable agricultural commodity in the comuna, and all of Loma Alta's farmers wish to expand their holdings. Two factors constrain the expansion of paja farming. First, paja toquilla requires humidity to thrive, thus accounting for the fact that only those individuals with plots near and within the premontane humid forest are able to grow it extensively. Second, while paja toquilla is valuable, it is also labor-intensive. Most landholders cannot afford to hire the additional labor required to expand their holdings. The distance of the forested areas from the settlements adds to labor costs.

The comuna itself places few constraints on landholders who want to cut down trees and grow more paja toquilla. Landholders enjoy secure rights to their land because they have been allocated plots by the comuna. No comuna rules exist to protect forested land from being cleared. Although the central government has recently banned commercial timber cutting and the hunting of deer in the forest, locals disregard the law since the government has only one forest guard for approximately eight comunas. Again, only the distance to the forest and the lack of capital to pay for additional labor constrain a rapid expansion of paja toquilla plantations. The cabildo is, in fact, ready to allocate another five hectares to any of the forest landholders if they so desire.

The practices associated with the cultivation of paja toquilla thus help to explain the patchy condition of the forest in its southern parts. The forest's distance from the closest settlements (El Suspiro and La Ponga) encourages farmers to estab-

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[14] The comuna allocated most of these areas to individual landholders in the 1960s and 1970s. This coincides both with the increasing dryness of lower comuna land and with demand for paja toquilla, which needs humidity to thrive.

lish plantations in the part of the forest closest to their homes. The shortage of labor prevents these plots from being very large.

The final user group we consider is comprised of the two individuals who hold land in the forest but who make their livelihoods by cutting wood rather than growing paja toquilla. The woodcutters selectively cut the trees on their own plots within the forest; the vast majority of the wood they sell, however, comes from the trees they cut in the comuna reserve. Because the trees in this area are almost free of cost—besides the costs of traveling to the reserve and extracting the timber—the woodcutters choose to deplete this land first, before they harvest from their own plots. Cutting from the communal plot also allows the trees on their land to "fatten" and thus become more valuable. The full-time woodcutters realize that they will be forced in the future to cut on their own plots to maintain their incomes. Demonstrating his belief that most of the valuable wood from the comuna reserve and individual plots will be removed relatively soon, one of the full-time woodcutters is "making connections" with members of another comuna in the hopes of either purchasing trees from its landholders, or getting access to land to continue his occupation of cutting and selling trees. The other woodcutter is "networking" with larger commercial timber companies to the north of the comuna, hoping to ensconce himself as the middleman between them and furniture makers located in coastal towns.

Incentives of user groups and the lack of institutional supply

The management of Loma Alta's watershed could provide substantial benefits to comuna members. A management institution offers the possibility of sustainable product flows, which would provide a more secure long-term supply of timber and other forest products to individuals. The institution could help protect the integrity of the comuna's borders, thus ensuring that outsiders would not exploit comuna resources. And the institution would allow comuna members to continue to benefit from two critical public goods provided by the Loma Alta Forest: climate maintenance and watershed services (e.g., fog interception, the prevention of erosion, groundwater storage, and water purification).

Along with these benefits, however, the creation of institutions to protect a natural resource entails considerable costs. It is costly to reach agreement between the members of a community about what rules should regulate forest use. It is costly to structure monitoring efforts that ensure these rules are not broken. And it is costly to resolve the disputes that will arise when rules are broken.

The physical characteristics of a forest also affect the costs of organizing a management institution. The fact that Loma Alta's Forest is relatively distant from the four major settlements makes any monitoring effort by comuna members more difficult than if they lived adjacent to its borders. Additionally, members of other comunas can enter the Loma Alta Forest easily—e.g., the forest is not protected by natural or artificial barriers—increasing the likelihood of invasion and requiring more monitoring activities.

To cover these significant costs, the users of the forest must perceive significant benefits from forestry management in order to desire and to contribute to the creation of institutions to regulate the forest's use. While users of Loma Alta's Forest value the forest for certain products, it appears that members of these groups do not perceive the benefits of a managed forest to be greater than its costs.

Individuals who hunt game in the forest and those who purchase wood to build homes have little incentive to create an institution to regulate the forest's use. The small number of game hunters do not depend on the forest for any significant portion of their livelihood. While they would benefit from a well-managed forest, since it would likely contain more game, the hunters stake in wildlife is relatively peripheral to their other daily activities.

Similarly, those individuals who use the forest's wood for constructing their homes have little incentive to shoulder the costs of forest management. While it is true that comuna members need wood to construct their homes, and that they would likely have to pay higher prices for wood in the future if all of Loma Alta's trees were felled, individuals reap the benefit of inexpensive wood in the present. Wood from the open-access comuna reserve is there for the taking; wood from the plots of private landholders is still available. Even if the forest was completely denuded, Loma Alta's residents believe that other comunas could meet their timber needs. Given the benefit that most members enjoy from the current lack of timber restrictions, most would not favor—nor be willing to support—an institution that might restrict forest use.

Thus, both game hunters and wood purchasers use the forest intermittently, have available substitutes for the forest products they value, and do not depend on the forest for their livelihoods. These two user groups share a pattern of incentives that mitigates their desire to contribute time, effort, or money to manage the forest.

Paja farmers, timber cutters, and outsiders, in contrast, use the forest intensively, perceive fewer available alternatives, and depend on the forest and its products for a significant portion of their incomes. Paja farmers claim that if they could secure more labor, or if the paths from their settlements to the forest were made easier to travel, they would cut down more trees to plant more paja, their most valuable crop. Like the paja growers, the profitability of the woodcutters' activities depends on a consumptive use of the forest in the present. The woodcutters are already removing timber at a rate that presses them to plan for the day when the forest can no longer provide them timber to sell.

Neither paja growers nor woodcutters have an interest in institutional arrangements that restrict their use of the forest. Paja growers know that forest trees and paja plantations cannot coexist within the same plot; any limitations on the expansion of paja plantings would constrain their ability to increase their income. Woodcutters know that their use of the forest is nonsustainable. Their preference is to cut trees without restriction while trees still exist to cut. While their own plots within the forest may boast relative health, this may be an artifact of their ability to use the comuna reserve, rather than a demonstration of any commitment to sustainable harvesting techniques. As long as the comuna reserve contains trees, woodcutters have the incentive to cut from that area first. When the reserve is completely denuded, it is likely that they will cut extensively on their own plots or in other comunas.

The outsiders who use the forest also favor the absence of forest regulations. The cattle-raising family has benefitted greatly from the fact that part of the comuna's forest remains open-access and unmonitored, and from the lack of local institutions regarding forest use. In the absence of such institutions, the family has seized hundreds of acres. Like the paja farmers and the woodcutters, the outsiders' type of forest use—turning it into pasture—also threatens the forest's survival in the long-term.

Significantly, only a few of the users are aware of the public goods provided by the forest; even fewer value these environmental services highly. Generally, comuna members have little knowledge of how the forest protects their watershed or affects their climate: while local nongovernmental organizations are trying to convince residents of various comunas in this region of the direct link between deforestation and the increasingly dry climate, paja growers and woodcutters do not mention these environmental concerns in discussions about their activities. Consequently, individuals value the forest for consumptive uses. And given the local economy and the rate of forest depletion, these consumptive uses appear unsustainable.

Conclusion

This study of the Loma Alta Forest highlights several issues regarding institutions, forests, and user groups important to policymakers concerned with Ecuador, as well as for scholars and practitioners interested in more general issues relating to the conservation of forests. The Loma Alta Forest shows deforestation rates which, if held constant, would result in total loss of trees on the remaining 950 ha. in the next 25 years. On average over the past 20 years, 10 ha. per year have been converted to paja toquilla and 30 ha. per year to pasture. Maintaining Loma Alta's Forest is crucial to the entire community: loss of the multilayered forest will reduce water input to the groundwater resources of the Loma Alta watershed. With less forest cover, the vegetative surface area for intercepting moisture from the air is reduced, local evaporation is increased, and less water percolates down to aquifers. Both rainfall data and local memory confirm that Loma Alta's prolonged drought parallels the rate of deforestation, causing scientists, some officials, and locals to think the phenomena are closely related.

Despite the importance of the forest to the entire comuna, this study has shown that conceptualizing Loma Alta as a single entity, or viewing the forest as one resource, may not be fruitful methods by which to diagnose the causes of Loma Alta's deforestation. By viewing a forest as a resource that provides a number of different commodities, and by examining the different groups who use these commodities, we provided an explanation for the lack of institutions regulating Loma Alta's Forest. While the comuna possesses most of the institutional assets that would favor the development of institutions, it has not yet created any rules regarding forest use. We found that those members with the biggest economic stake in the forest have no reason to limit their exploitative practices, and thus little demand exists for forest regulation at the local level. This lack of forestry institutions has led to an outcome whereby Loma Alta's Forest, while having some areas of relatively good secondary growth, is in danger of being more severely degraded in the near future.

Although no forest institutions exist in Loma Alta, we found that rules have had a direct impact on the forest's condition. The comuna's property-rights institutions, for example, provided a partial explanation for the pattern of forest use and current forest condition. As predicted by most property-rights theorists, the comuna reserve—that part of the forest without individual landholders—is the most seriously degraded (Demsetz, 1967; Libecap, 1989; North, 1990). Landholders, nonlandholders, and even noncomuna members choose to cut trees in the reserve first when they seek timber. Those plots with individual landholders, on the other hand, contain areas with less forest exploitation.

The Loma Alta case also demonstrates that strong individual property rights alone do not guarantee a forest's health. Landholders in Loma Alta possess incentives that do not favor the forest's long-term sustainability. Paja toquilla farmers would choose to expand their holdings of paja—which generates a certain and relatively long-term stream of income—over preserving the forest. Similarly, woodcutters only earn income with the removal of trees; even though their livelihood depends on some minimum population of trees, their short time horizons favor the complete removal of the trees before they consider a shift to other occupations.

To prevent continued deforestation in the Loma Alta area, policymakers must address the incentives that drive the behaviors of those users most crucial to the forest's existence, *viz.* the farmers of paja toquilla, the woodcutters, and the outside invaders. Only when these actors consider alternative, less destructive activities to be of greater value than their present, more destructive practices, will the forest's exploitation be limited. Part of the task confronting those interested in the long-term survival of the forest is to link comuna members' perceptions of the forest with its provision of public goods. If the forest's effects on the watershed and weather were more widely understood, locals may be more willing to support an institution that manages the forest's use.

Even if most comuna members highly valued the forest's public goods, however, there still remains a collective-action problem in the supply of institutions, e.g., although everyone benefits from the forest, it is an individual's interest to free-ride on the contributions of others (Olson, 1965; Ostrom, 1990). Given that no individual or small group in Loma Alta appears desirous of bearing the costs of starting a management institution, there may exist a role for nongovernment or government organization to cover such start-up expenses (Thomson, 1992).

While considerable challenges confront those who wish to limit or stop Loma Alta's deforestation, the comuna possesses significant advantages over other rural areas. First, the population of the Loma Alta comuna is roughly stable. Approximately half of the young adults are leaving the area to pursue better employment opportunities in coastal urban areas. The lack of population growth means that the pressure for farm land and timber may not increase rapidly in the near future. Second, the institutional assets of Loma Alta, discussed in the second part of this chapter, will be valuable to any attempt to construct a local solution to deforestation, despite the fact that the comuna presently has no institutions to regulate the use of their forest (Smale and Ruttan, 1995). The comuna's power to allocate property could be at the center of a policy that attempts to reserve land for watershed protection. The comuna's long history of member participation in committee building could facilitate the construction of monitoring and sanctioning devices as well as assist their staffing by comuna members. Finally, the comuna's experience with intragroup compromise will be critical to discussions that attempt to balance the goals of the comuna as a whole with members who stand to lose benefits if the comuna limits the use of its forest.

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Chapter 7

Indigenous Forest Management in the Bolivian Amazon: Lessons from the Yuracaré People

C. Dustin Becker and Rosario Leon

Introduction

Societies have been making choices about their relationships with forests for many centuries. As reviewed by Perlin (1991), the dominant choice for the last 5,000 years across Asia and Europe, and more recently in the Americas, has been to cut down trees, use them for fuel and building materials, and replace them with crops or urban centers. In contrast, numerous neotropical cultures have evolved societies that sustain rather than destroy forest ecosystems (Chernela, 1989; Posey, 1992). Such ecologically oriented cultures are rapidly disappearing. Mutualistic relationships between forests and people in the tropics are changing as activities in the forest are modified by incentives structured by market forces, government forest policies, and by concomitant changes in the values of indigenous peoples. This study explores the changing relationship between the Yuracaré people and the forest communities they sustain and use along the Rio Chapare in northern Bolivia. It finds that while certain external threats do affect the condition of the Yuracaré's forests, a significant amount of local-level management continues to exist.

Historical and ecological setting

In the early 1990s, national policy in Bolivia shifted from ignoring the rights of indigenous people in the Amazon to taking them into consideration. The policy change came about in response to internal land tenure conflicts and political organization by indigenous groups (Paz et al., 1995). Years of conflict between families indigenous to the Amazon and settlers from more populated regions of Bolivia led to protest by native groups. In 1991, indigenous Amazonians of Bolivia staged a march "for their territories and dignity" (Paz et al., 1995). This political unrest, combined with the decentralization policies of international donor agencies, prompted the Bolivian government to overturn the "Law of Colonization." This Bolivian law (Art. N107765), promulgated in 1966, declared the lands of the Amazon to be uninhabited and open for colonization. With the negation of the old law, indigenous groups are now recognized and are currently being given legal authority over their traditional territories. The government plays a supervisory role by evaluating petitions for land tenure from indigenous groups in the Amazon.

As a prerequisite for acquiring title to the lands and waters they have used for the past 400 years, the Yuracaré are required to create a management plan for the stewardship of the natural resources within their traditional boundaries (CERES, 1997). This requirement implies that the Yuracaré lack forest management, a supposition that has never been questioned or explored. It has also invited external assistance and influence in defining and creating a "modern" management plan. In this chapter, we assess whether the Yuracaré truly lack a system of forest management, and secondly what sort of socioeconomic forces are likely to influence them as they try to forge a forest management plan that will be acceptable to government decision makers.

The Yuracaré people have one of the last remaining forests in Bolivia that is clearly under indigenous control. Approximately 400 Yuracaré families live in the northeastern part of the Department of Cochabamba. They currently claim about 250,000 hectares of the Rio Chapare watershed as their territory. In 1994, the Yuracaré began a collaboration with the Forests, Trees and People Programme (FTPP) of FAO based at the "Centro de Estudios de la Realidad Economica y Social" (CERES) with the goal of making an official forest management plan to respond to the Bolivian government's new policy.

CERES conducted an International Forestry Resources and Institutions (IFRI) study to provide an initial understanding of the relationship between people and forests in the Yuracaré culture (CERES, 1997). Three settlements along the Rio Chapare—Missiones, Trinidadcito, and Santa Anita—and their associated forests were studied by CERES (Figure 7.1). The settlements are located in three "life zones" (Holdridge, 1967), all of which may be broadly classified as lowland tropical moist forest. Missiones is positioned in the life zone referred to by Holdridge (1967) as "wet tropical forest." Here rainfall ranges from 2200 to 4400 mm per annum, and temperature ranges from 17 to 24° C. Trinidadcito is in "moist tropical forest" and receives between 1900 and 2800 mm of rain each year, and temperatures remain relatively constant, 22 to 24 ° C. Santa Anita receives 1250 to 1450 mm of rain each year, and thus supports a forest that is transitional between dry and moist (ibid.).

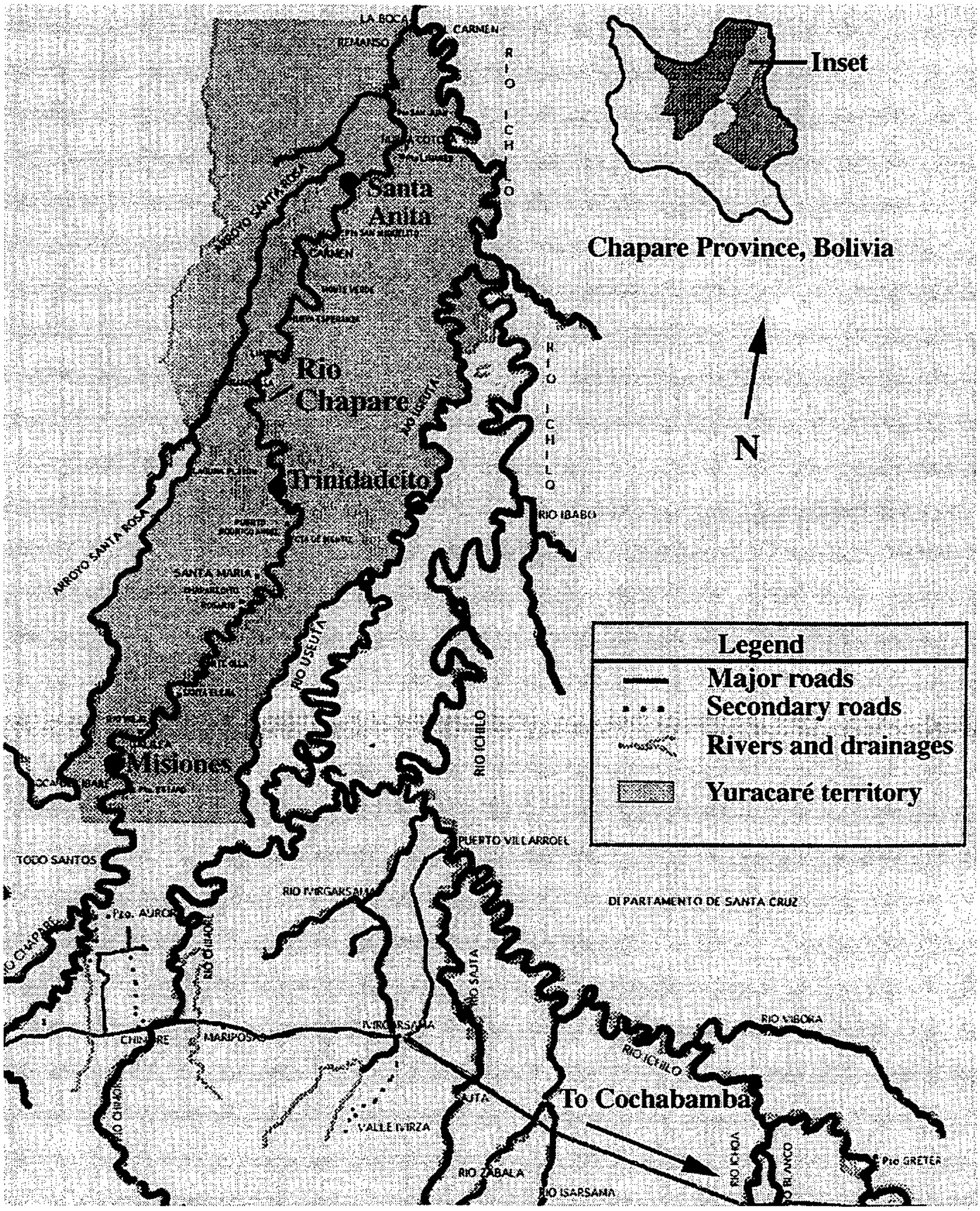


Figure 7.1: **Location of Yuracaré territory, settlements, and forests on the Rio Chapare, Bolivia**

The Chapare River has as much influence on vegetation communities as rainfall. Alluvial soils have been deposited at all sites studied by CERES, and moisture and erosion have established a riparian forest community that is fairly homogeneous in species composition along the entire river. The most common tree genera are palms, *Astrocaryum* and *Scheelea*, and fruiting hardwoods, *Guarea*, *Inga*, *Rhipidocladum*, *Theobroma* (wild cocoa), *Virola*, and *Hura* (CERES, 1997). In disturbed areas, early successional trees genera, *Inga* and *Cecropia* dominate the vegetation community.

Inventories by the Bolivian forestry organization, PRODES, determined that the potential for timber extraction in Yuracaré territory was as high as 49 m^3 per hectare (Rojas, 1996). Bolivia's Department of Forestry (DIDF) set quotas on timber extraction in the Rio Chapare region based on these estimates, and encouraged the Yuracaré to organize forest associations to meet these quotas. In response to this marketing incentive, the Yuracaré did in fact organize their own forest associations and privatized the most valuable timber.

Themes, definitions, null hypotheses, and corollaries

In this chapter we use data from the CERES-IFRI study to explore whether or not the Yuracaré have a tradition of forest management. To address this question it is also necessary to examine what other important factors may be influencing the condition of the forest. Consequently, in addition to studying Yuracaré institutions that might affect the forest, we also investigate the effect of moisture gradient, population pressure, and distance from market. Because the CERES-IFRI study includes data from both the natural and social sciences, we were able to include factors from both of these traditions. We use social science data to determine whether there are social norms in place that are directly aimed at forest stewardship. We use data from forest stand inventories to look for physical evidence of forest management by the Yuracaré. The intensity of forest use varies along the river. By comparing the riparian forest at three sites that vary greatly in their distances to market and intensity of use (population pressure), we can begin to assess how the ingress of the Bolivian market economy is influencing the forest and the Yuracaré's relationships with it.

Consistent with theory developed in the IFRI research program (see Appendix I to this volume), we define forest institutions as rules or social norms applied to forest goods and services. A rule is considered to be a social regularity with deontic content (implication of "must" or "must not") that is observable, interpretable, or that may be explained by a local person (Ostrom, 1992). The Institutional Analysis and Development (IAD) framework, upon which IFRI is founded, considers actions taken at several levels of social organization: operational, collective choice, and constitutional (Ostrom, 1990). In this case, the "operational" level refers to actions of individuals that affect the state of the forest (i.e., harvesting, transplanting, pruning, culling, etc.). "Collective choice" applies to actions of individuals that affect the operational level (i.e., prescribing, invoking, monitoring, enforcing, etc.). Finally, actions at the "constitutional" level affect collective choice by determining who prescribes, invokes, monitors, or enforces rules.

We pose the following null hypothesis: Yuracaré people living on the Rio Chapare of Bolivia lack forest management institutions. If this is true, and drawing from the design principles of Ostrom (1990), it follows that the Yuracaré will *lack* constitutional, collective choice, or operational activities that:

1. Prevent destruction of important forest resources.
2. Encourage activities that conserve or restore forest resources.
3. Clearly define boundaries (Ostrom, 1990) and access to forest resources.

These are all typical forest management activities or norms that sustain forests (Aplet et al., 1993). Sustainable forests may result from either constraining use or from reforestation, and long-term resource management may contain elements of both strategies. Boundaries may be organized at many levels, such as individual (e.g., rights to specific trees), family (e.g., areas managed by a group of relatives), and regional (e.g., use defined by membership in an indigenous group).

Borrowing from cultural anthropology, the null hypothesis also predicts that the Yuracaré will lack language pertaining to forest management, especially regarding aspects of sustainable use such as long-term planning and constraints on individual use. More specifically, the null hypothesis predicts that the Yuracaré will demonstrate:

1. Little knowledge about forest resources in language or traditions.
2. No awareness of resource depletion, nor actions to remedy it.
3. No conceptual awareness of the role of individual constraint in sustaining a natural resource common.

Again these predictions relate directly to the potential of any society to sustain a biological resource base while they use it. The managers must have basic knowledge about the distribution and abundance of the resource to be managed, and knowledge of how that resource reproduces and grows. They must also be able to detect depletion, and to modify use in such a way that the resource can recover or hover around some equilibrium population size that sustains use over long periods of time.

Forest condition along the Rio Chapare should reflect ecology and human utilization as influenced by population density, market demand, and their institutions that control use of forest products (Figure 7.2). Because forests are relatively old systems, a long time horizon must be considered. Current forest biomass and diversity may reflect decisions and actions made decades (even centuries) in the past as well as those made recently. To evaluate the past and present social impacts on forests, we use paradigms and techniques of forest ecology. Forest condition is defined by measurable physical and biological aspects of a plant community dominated by trees and other woody plants. Measurements include but are not limited to: central tendencies for biomass, basal area, species diversity, density of woody stems, canopy cover, as well as spatial distributions of disturbance, ground cover, and particular plant species (IFRI, 1997).

Biomass of trees and species diversity might vary in response to population pressure, market demand, and according to forest management rules. However, moisture gradients and stochastic patterns of seed dispersal and herbivory are equally viable explanatory factors for variation in forest structure and composition (Spurr and Barnes, 1980). How does one determine when forest condition reflects societal (institutional) outcome rather than ecological pattern? This sort of challenge can be solved with a research design that varies institutions over a similar ecology or a design that partitions ecology and sociology. In this case, we use a river moisture to tease apart the structuring forces of ecology and human use.

Moisture gradient hypothesis

We assume continuity in regional climate over the life of the forest (last 200-300 years), so the rainfall gradient documented for the Rio Chapare should affect basal area, species abundance, and distribution. As mentioned above, Missiones receives more precipitation per year on average, than Trinidadcito, and Santa Anita receives the least. Trees should thus have largest diameters at breast height (dbh)[1] in Missiones, where rainfall is plentiful; while progressively smaller values should be found in Trinidadcito and Santa Anita for within species comparisons.

Population density hypothesis

Of the approximately 1,800 inhabitants along the Rio Chapare, populations of about 600 are permanent at Missiones and Santa Anita. In contrast, Trinidadcito has no permanent settlement and thus population pressure has been historically low there relative to the other two settlements. If density-dependent effects of

[1] *This standard measurement of tree diameters is taken at 1.4 m and is used to calculate basal area* $= \pi * (dbh/2)^2$.

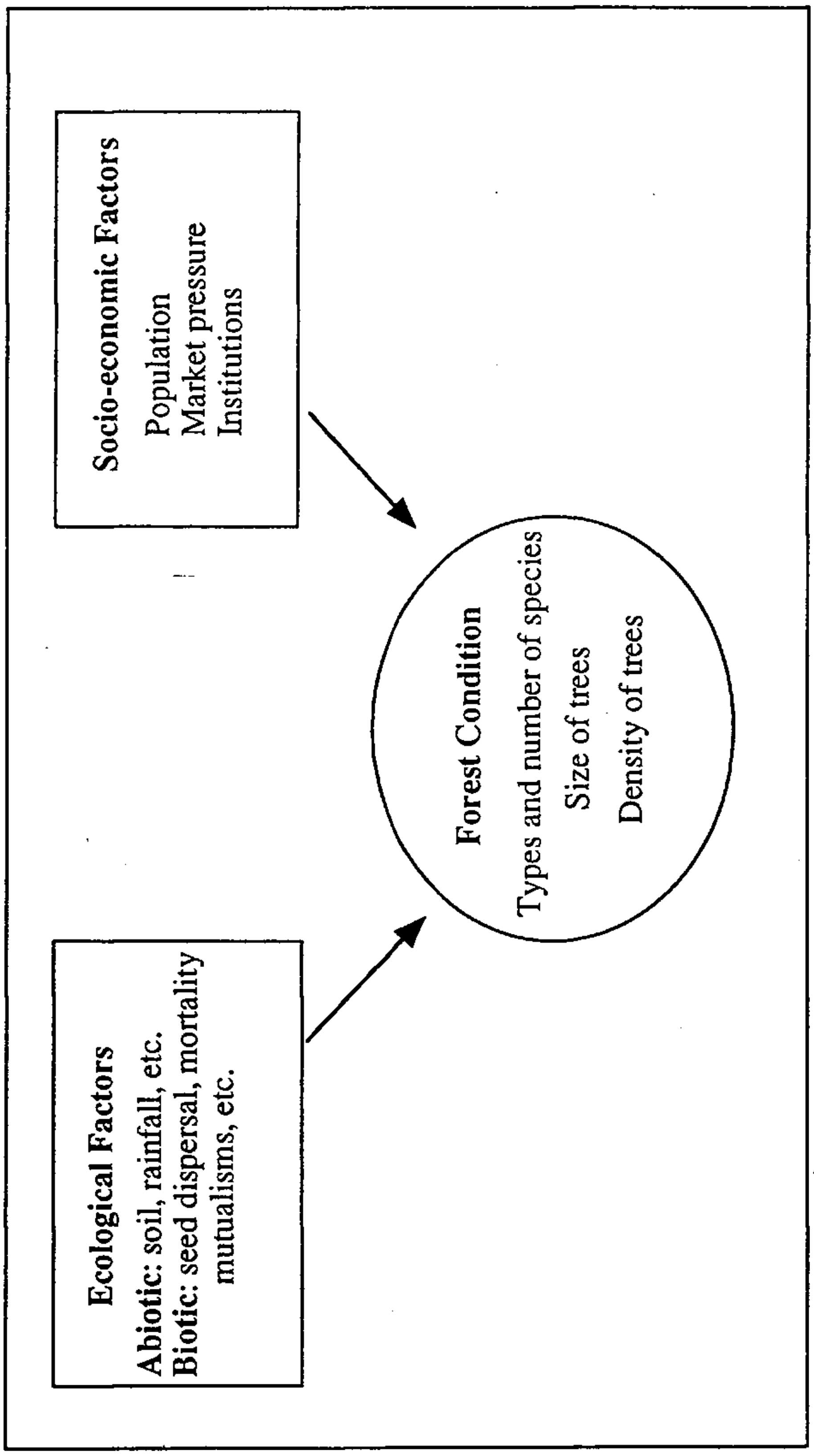


Figure 7.2: Social and ecological factors that influence forest condition

resource utilization influence the forest, one would expect a pattern of "low-high-low" for measures of density (trees per hectare) and basal area of trees in Missiones, Trinidadcito and Santa Anita, respectively.

Market demand hypothesis

Opposite to the effects of moisture gradient, commercial timber species should show an increase in density and basal area with distance from Cochabamba, because market pressure declines with distance from a major trading center. The largest trees will be harvested where the cost to get them to market (distance) is the least. Commercial tree species should show a pattern of "low-medium-high" for basal area and density in Missiones, Trinidadcito, and Santa Anita, respectively.

In addition to being influenced by moisture gradient, population density, and market forces, forested areas around each settlement have been partitioned into "communal" and "family-managed" units. Following the logic popularized as the "tragedy of the commons" (Hardin, 1968), communal forests would be expected to have lower densities and basal areas, while family-managed forests should be better conserved and stocked. Table 7.1 summarizes the ecological and socioeconomic variables hypothesized to influence forest condition, and reveals that each alternative hypothesis has its own mutually exclusive outcome. Now we can compare the average density, dbh, and basal area of tree species used for commercial timber, domestic timber, and for fruits and medicines and see which factors best explain their current distribution and abundance.

Table 7.1: Predicted relative values for stem density and basal area of tree species in forests associated with three settlements on the Rio Chapare, Bolivia. Pictograms of outcome follow each causal factor.

	Relative Mean Values for Stem Density and Basal Area		
Forest Structuring Factor	Missiones	Trinidadcito	Santa Anita
Moisture gradient - - _	Large	Medium	Small
Human population pressure _ - _	Small	Large	Small
Market pressure _ - -	Small	Medium	Large
Tenure	Family plots > Community forest plots at all three sites		

Methodological details and a reference forest

Institutional analysis and forest stand inventories—standard methods of the IFRI research program (see Appendix I to this volume)—were completed for five forest sites (CERES, 1997). Information about social norms and institutions was obtained during visits with Yuracaré families and at larger community gatherings, using participatory rural appraisal (PRA) activities and informal discussion. Data were entered on standardized IFRI forms. Forest plot data (IFRI, 1997) were aggregated by communal and family forest areas at Missiones and Santa Anita, but such tenure differences were not in place at Trinidadcito (not a permanent settlement).

Within each forest stand, trees were sampled in circular plots with a 10 meter radius. Plots were systematically placed at 100 meter intervals along one kilometer transects perpendicular to the river and exclusively in mature riparian forest. Areas cultivated with annuals and monocultures of perennials like bananas were purposefully excluded from the forest sampling effort. Transects were positioned in stands of trees that have remained under use by the Yuracaré over the past few centuries. Sample sizes were stratified according to the size of the forest remaining near each settlement. Because biological diversity typically increases with area sampled, we compared richness within one-hectare areas, unless reported otherwise. We use species and family richness (number of tree species and families per hectare) as a measure of biological diversity in the different forest sites.

In order to put the human impact on the riparian forests of the Rio Chapare into context for the western Amazon region, we compared our data with those describing the riparian forests of Manu, Peru, a large protected area (Gentry and Terbourgh, 1990; Foster, 1990). Manu's stands serve as a pseudo-control or reference forest because they have been protected from timber exploitation and have not been used intensively by indigenous families for at least four decades. We predict that the riparian forests used by the Yuracaré will differ from Manu as follows:

1. Basal area of trees will be consistently lower at all three settlement areas than at Manu.
2. Diameters at breast height (DBH) will be consistently smaller along the Yuracaré than at Manu.
3. Tree diversity on the Rio Chapare will be substantially lower due to human use.

Results

Forest management institutions created by the Yuracaré

The Yuracaré have clearly defined boundaries, systems of monitoring resource condition, and rules that directly pertain to forest resources. Yuracaré institutions control access and use of the forest at multiple levels: Clan (extended family), *Corregimiento*, and Territory. Tribal territory and clan areas are largely predicated on providing families within clans with sufficient game meat and other natural resources. Clans are the core of the Yuracaré social system, consisting of an extended family made up of 10 to 20 nuclear families (husband, wife, and children). Clans have organized themselves into eleven "*Corregimientos*"[2] along the river. Within each *Corregimiento*, "*Kuklete*" or family forest gardens are created, cared for, and monitored like private property. Families state that they "own their work," but not the land *per se*. While territorial tenure is important for the Yuracaré people-forest relationship, permanent private landholdings are not, because families strategically move within their *Corregimiento* and within the entire territory, creating forest gardens and obtaining forest resources. Thus, each family has a stake in organizing to maintain control over the whole watershed, and their institutions reflect this landscape-level concern for sustaining their resource base (Table 7.2).

Using a consensus approach, representatives from each clan elect a "*Cacique Mayor Yuracaré*"[3] to lead them. Likewise, each *Corregimiento* has several representatives that participate in a tribal council (*Consejo Indigena Yuracaré*). This council uses a system of one person-one vote, and majority rules, to make major decisions and plans that concern the Yuracaré as a whole. Since territorial control is the major concern of the Yuracaré, council meetings tend to focus on political conflicts with other indigenous groups and on interactions with external agencies (e.g., government, church, NGOs).

Most forest management activities (operational) and decisions (collective choice) are made at the family level within clans. Families have an informal system for monitoring resources and their use within their *Corregimiento*. The approach is completely decentralized, but replicated within the entire territory. Information on resource distribution, such as the locations of timber species, excellent hunting areas, trees in fruit, and areas that are good for cultivation, is well established

[2] *Corregimiento is related to the noun corregidor which refers to a Spanish magistrate. In this case, the term applies to a spatially defined unit of governance organized by a Yuracaré clan(s).*
[3] *Cacique—political leader. Also name of colorful, loud, social birds in the neotropics from which feathers are used to decorate leaders.*

for each *Corregimiento*. Families in each *Corregimiento* do informal inventories of resources by walking and canoeing throughout their region and discussing the spatial distribution of resources. Over the centuries this knowledge has been systematized and used to classify soils, to design a system of forest agriculture, and, more recently, to exploit commercial timber (Paz et al., 1995).

Table 7.2: Framework of Yuracaré forest institutions

Social Level	Operational	Collective Choice	Constitutional
Individuals Families Clans	Fruit tree planting. Culling for fruiting trees. Protection of fruiting trees. Harvesting timber trees.	Allocation of land to families. Where to develop family tree gardens vs. leave the communal forest.	Defining clan membership. Familial decision making. Selection of Clan leaders.
Corregimiento (subregion)	Monitoring resource use. Sanctioning abusers.	Allocation of land/ forest to different clans. Deciding on ownership of commercial tree species.	Membership in a forest association. Clan leaders comparing use within their areas.
Territory (watershed)	Monitoring commercial timber. Sanctioning abusers.	Families interacting with clan leaders and *Cacique* (Yuracaré chief) to resolve tree tenure conflicts. Meetings held when needed.	Clan leaders comparing use within their areas with input from forest association and government.

Exploitation of commercial timber created conflict and challenged Yuracaré institutions, because at first certain individuals accrued more benefits than others. Clans have devised a system of tree ownership to distribute this wealth more equitably. In 1991, forest associations were formed in each *Corregimiento* to organize timber exploitation and to interact with government forestry departments and timber buyers.

Both constitutional and collective choice levels of organization are represented by social norms that prescribe actions pertaining to forest management in Yuracaré culture. For example, a frequently mentioned norm was that "ALL Yuracaré must care for the forest." When asked why, the typical response was "so the animals will come." Rights and obligations are thus created and enforced by the Yuracaré as a group. Operationally, "caring for the forest" includes protecting fruiting trees, and transplanting and selectively encouraging fruiting trees in order to increase densities of game. Yuracaré also have game management rules including selective harvesting of the males, and no-hunting seasons. When rules are broken, sanctioning is traditionally accomplished via social reprimand and ostracism, but with the growth of commercial timbering, these mild social sanctions have been inadequate at times. For example, sometime in the last five years, a man harvested and sold trees belonging to another family and this required resolution between two clans. The norm-breaker was required to split his income from the sale of the trees with the original owner.

Well before the organization of forest associations, Yuracaré language and traditional norms included explicit prescriptions for sustainable forest management. At the collective choice level they prescribe "use of forest trees and animals without depletion." This prescription is operationalized through a "mobile multiple use" relationship with the forest and through the creation of fruit tree gardens. Rather than using any one forest area intensively, families spread out the impact of timber harvesting, agriculture, hunting, and gathering in time and space. Movements include complex local and regional patterns, a full description of which is beyond the scope of this chapter. However, seasonal variation in resource use and collection of resources over a large area probably prevent depletion of patchy resources in any one area. The Yuracaré practice long-term biodiverse perennial agriculture in small forest patches. Areas with productive soils, "*ti jukule*," are first planted with yucca, then bananas, and then fruit trees (mango, chocolate, orange, coffee, grapefruit, palms, native fruit trees, etc.). The forest tree garden is used for 25 to 35 years eventually becoming mature rain forest, dominated by domestic and wild fruiting species. The Yuracaré promote growth of the wild fruiting species by removing nearby seedlings that would compete for water and nutrients.

Yuracaré institutions are highly responsive to external incentives. In 1992, the Yuracaré decided to organize forest associations in each *Corregimiento* to coordinate with external government forest agencies and timber marketing associations. Two laws, the "Forest Law and the Law of INRA (Rights of Indigenous Peoples)," have extended exclusive rights to forest exploitation to the Yuracaré within their territory, but under certain constraints imposed mainly by government forestry agencies. The forest associations have worked to allocate resources, weaken constraints (e.g., relax rules against use of chainsaws), and to resolve conflicts among themselves. To reduce conflicts over valuable timber, the Yuracaré forest associations privatized Mahogany and Spanish Cedar in community forest areas. Since these forests are already rather equally distributed among family areas via the *Corregimiento* system, the private goods within them were relatively easy to distribute.

Yuracaré language and forest management

The Yuracaré have many sayings that explicitly relate to sustaining a diverse tropical forest ecology. Their language is replete with statements about the Yuracaré's role in a food chain based on fruiting trees. The following phrases are translations illustrating a linguistic familiarity with the ecological concept that forest fruit feeds game animals, and game animals provide food for the Yuracaré:

1. "to be human one must eat meat"
2. "When the ambaibo (*Cecropia*) fruits, the animals get fat!"
3. "Yuracaré must care for the forest"

In addition to stating that people should "use forest trees and animals without depletion," the Yuracaré have the saying "*Cuivalimatu tëpshë dulashtututi nomajsha*" which translates as "one should plan for the future." Such language illustrates a familiarity with conservation principles that underlie sustainable use.

When asked to name natural resources, wild forest fruits and animals had a higher proportion of indigenous names than timber and agricultural species (Figure 7.3). This result is not surprising given that Yuracaré culture was totally dependent on forest resources prior to colonial influence. What is more important is that the Yuracaré named 52 fruiting tree species that they actively monitor, protect, and promote. The Yuracaré have spatial concepts of their forest resources as evidenced by maps they made during Participatory Rural Appraisal (PRA) exercises (Figure 7.4). While their geographic information system (GIS) may lack precision (e.g., not to scale), it accurately depicts locations of forest resources, forest cover classification, water resources, and use patterns.

Variation in forest condition

As shown in Table 7.3, forest condition at the three sites on the Rio Chapare differ substantially. Despite having higher rainfall that would favor large mean basal area and good regeneration, Missiones had the lowest values for both of these important indicators of forest health. Forests in Missiones, where timber exploitation was heaviest, had a basal area of only 28 m2/ha, while stands in Santa Anita averaged 38 m2/ha.

In general, the mean basal area of trees along Rio Chapare increased with distance from market (Table 7.3). Basal area was not consistently lower on family plots, nor was it lower than the mean basal area at the Rio Manu protected area. Average basal area was largest for family plots at Santa Anita, a result best fitting predictions for distance from market. Diameter at breast was larger along Rio Chapare than Rio Manu (Table 7.3), and significantly smaller at Missiones than at Trinidadcito and Santa Anita (ANOVA, df = 4, p = 0.02).

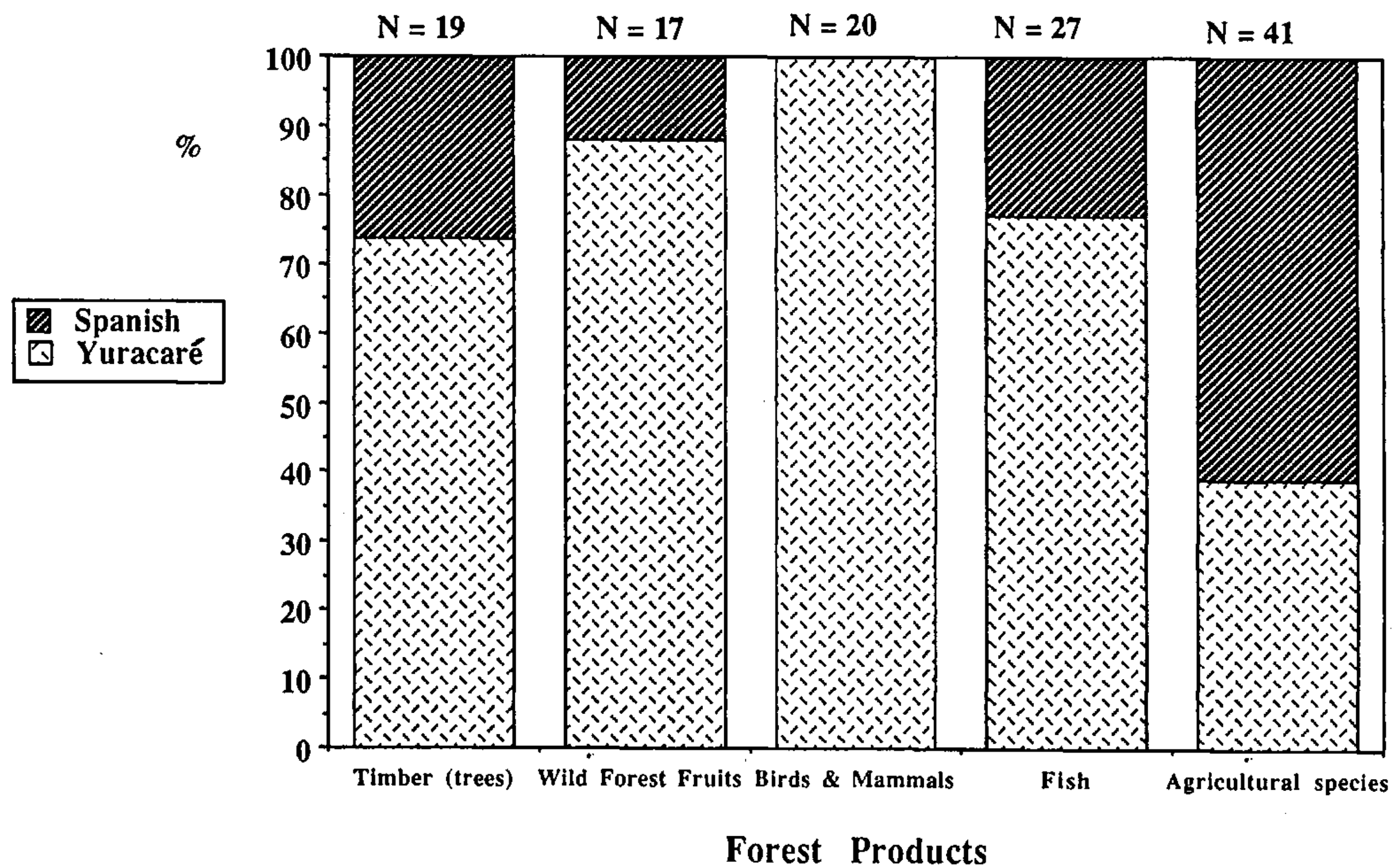
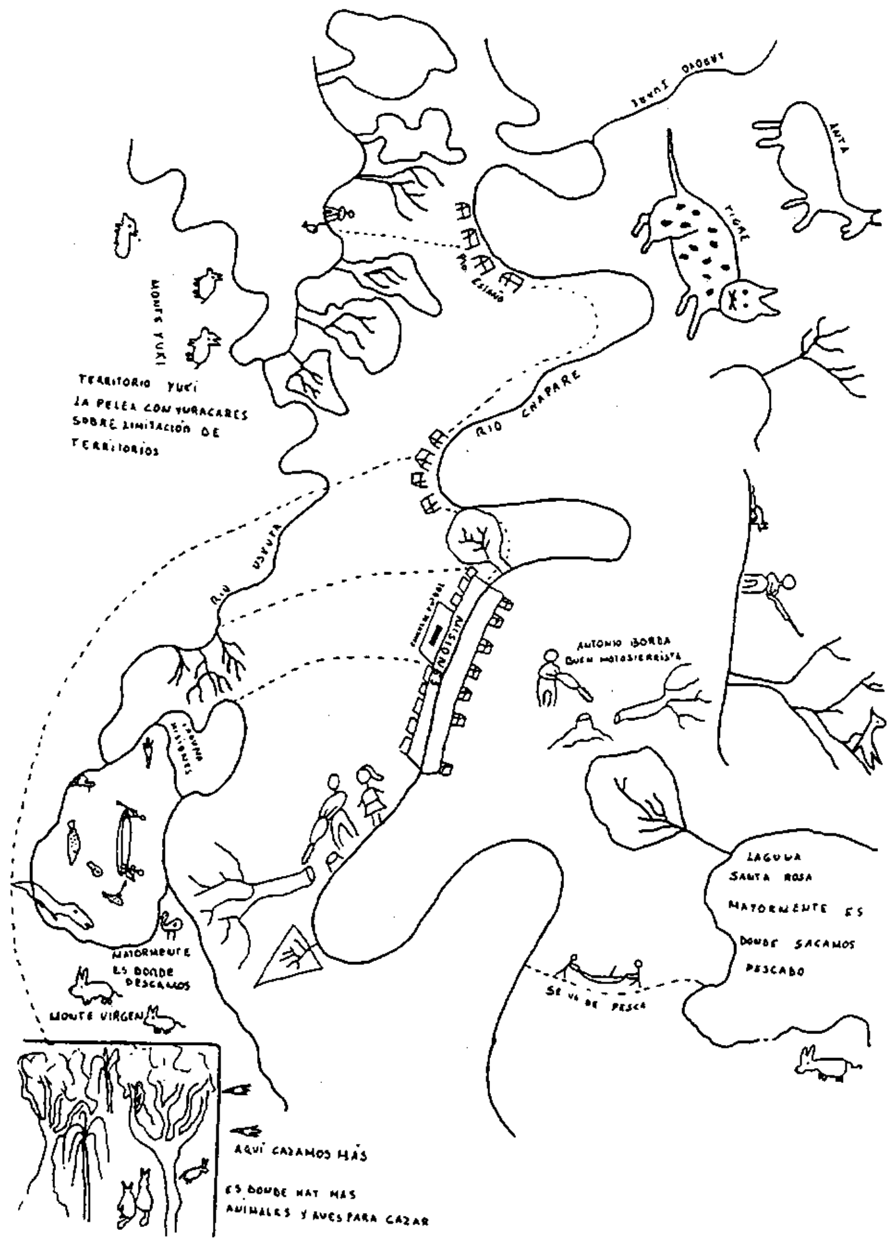


Figure 7.3: Proportion of different natural resources with Yuracaré and Spanish names. Wild forest fruits, birds, and mammals have higher proportions of indigenous names than timber trees, fish, and agricultural resources.

MAPA 10

BOSQUE COMUNAL DE MISIONES (COMUNIDAD INDIGENA YURACARÉ)



Fuente: Comunarios de Misiones (Pueblos indígenas Yuracaré)

Figure 7.4: People-forest relationship map made by Yuracaré living in Missiones. Illustration emphasizes a utilitarian relationship with the forest ecosystem, including use of chainsaws for timber harvesting (Paz et al.,1995).

Table 7.3: Tree basal area, density, and diversity at Rio Chapare sites
(Comparison with "pristine" Rio Manu forest trees ≥ 10 cm DBH. All sites are on alluvial deposits.)

	Missiones		Trinidadcito	Santa Anita		Rio Manu
	Familiar	Comunal		Familiar	Comunal	Cocha Cashu[1]
Annual Precipitation (mm)	2280 - 4400		1900 - 2800	1250 - 1450		2028
Basal Area: (m2/hectare)	27	29	33	40.3	36	37
Trees/hectare	319	333	363	310	366	650
Mean dbh ± se	24.7 ± 1.2	24.4 ± .7	27.1 ± .45	27.8 ± 2	26.4 ± 1.3	22.6**
Tree Diversity Tree Species/ha: Tree Families/ha: Tree Families/>10ha:			 45-60* (for all sites) 23-29 (for all sites) 34 (for all sites)			 155-283 45 N/A
% Palms***	2	8	17.5	1.8	1.5	15.3
Local Land Use	Market and Family		Mobile Family	Family and Ranching		Tourism

[1] "Pristine" upper Amazon alluvial floodplain forest (Gentry and Terbourgh, 1990).
* Lower value may result from difficulty of identification at species level, although Family count is also lower.
** Calculated by taking mid-point values of size classes from Table 27.1 (Gentry and Terbourgh, 1990).
*** *Astrocaryum, Iriartea, Scheelea*

Mean density of trees varied as a consequence of use along the Rio Chapare, and was only half the value for Rio Manu. While the Rio Chapare forests had from 310 to 366 trees per hectare, Manu had 650 trees per hectare. When the distribution of size classes are compared for the two river systems (Figure 7.5), a pattern consistent with market incentives and traditional forest management may be interpreted. Trees with diameters of 26 to 40 cm were clearly less abundant in the Rio Chapare sample than at Manu, probably a consequence of timber harvest. Large diameter (fruit trees), however, were more abundant in the Rio Chapare sample than in the Manu sample. There were also more trees per hectare in the communal forests than in family forests (not significant at the plot level), opposite to a "tragedy of the commons" scenario.

Tree species diversity along the Rio Chapare was low relative to Manu (Table 7.3). While botanists found as many as 283 different species in one-hectare samples at Manu, the maximum value on Rio Chapare was 60 species. Comparisons made at the family level (where identification skill is less likely to bias results) also suggest that forests along the Manu are more diverse than those associated with the Rio Chapare. Trees in one hectare at Manu represented 45 families, while only 34 families were found in the Rio Chapare study in an area of more than 12 hectares.

Dbh of trees used indigenously averaged 10 cm larger than commercial species, suggesting that market pressure has lowered the biomass of timber species, while species used for fruit, local building material, and medicines have been conserved (Table 7.4). Nine of the 10 most abundant tree species in the Rio Chapare samples were fruiting species used by birds and mammals that are traditional foods of the Yuracaré. Still, several noncommercial species such as *Amendrillo* and *Crespito* had very low regeneration values, and *Yesquero* had no evidence of regeneration (Table 7.4). Two timber species of traditional importance, "Gabun" (Virola peruviana) and "Guayabochi" (Calycophyllum sproceanum) show little regeneration in the Misiones forest samples suggesting that they may be overexploited there. Seedlings and saplings of two medicinal trees, "Paraquina" (Ephedranthus amazonicus) and "Gabetillo" (Sloanea rufa), were also nearly absent in the Missiones plots.

Of the 34 tree species with economic importance to the Yuracaré, 9 exhibited changes in density and dbh that would be expected along a gradient of soil moisture (Table 7.5). When biomass profiles (dbh and stem density) are compared (Table 7.5), commercial timber species were more likely to be depleted than traditional timber species. None of the traditional timber species showed the "low-medium-high" profile consistent with market pressure. Given the lack of market profiles in the more abundant traditional use species, it is possible that "depleted" species in this category are rare species. Eleven of 28 species with traditional uses (Table 7.5B and C) showed reductions in density and diameter consistent with population pres-

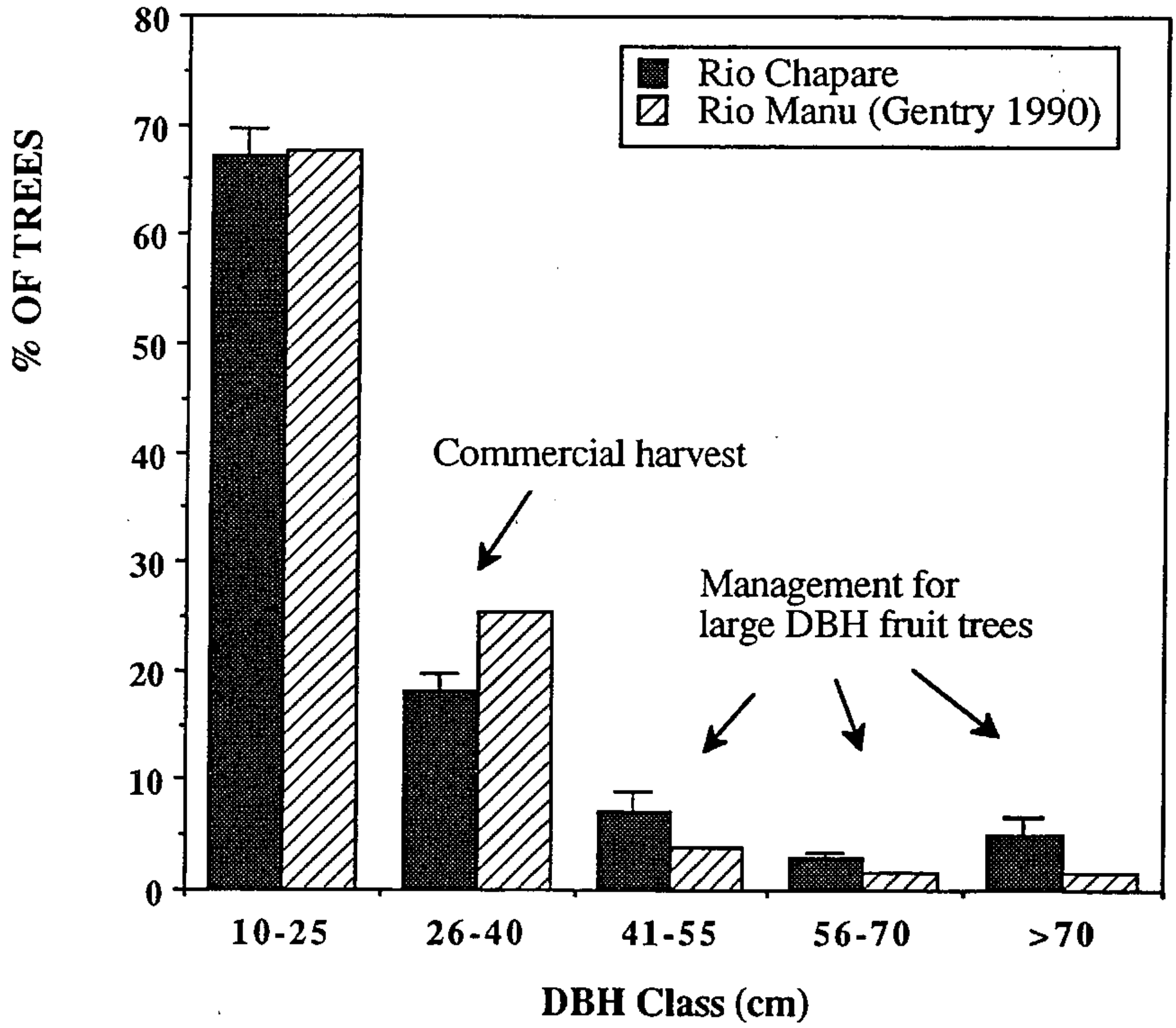


Figure 7.5: Comparison of size classes (DBH) of trees in forest stands on the Rio Chapare and on Rio Manu

sure. Three species had similar average values at all sites, and only two species had profiles that did not fit any predicted pattern.

Table 7.4: Estimates of trees ha^{-1} of commercial and noncommercial timber species on the Rio Chapare, Bolivia (Genera in parentheses). Data from the five IFRI forests were pooled because there were no statistical differences in tree or sapling densities by site. Estimates are derived from 386 plots totalling 12.12 hectares. Sapling estimates are based on a 1.1 hectare aggregate of 386 plots, each covering 28.3 m^2. Sampling was stratified by forest size, so these data are biased towards Trinidadcito where 57% of plots were completed.

Commercial Species	Trees/ha	Mean%	Ave. dbh	Saplings/ha
Trompillo (*Guarea*)	13	3.5	19	122
Gabun (*Virola*)	12	3.2	32	48
Verdolago (*Terminalia*)	6.1	2.3	33	11.8
Laurel (*Ocotea*)	1.9	< 1	22.4	11.8
Palo Maria (*Calophyllum*)	.74	< 1	36.5	.9
Cedro (*Cedrela*)	.14	< 1	15.6	1.6
Mara (*Swietenia*)	0	-	-	0
Total ~ 34 mean = 26.4				

Noncommercial Species	Trees/ha	Ave. dbh	Saplings/ha
Jorori (*Swartzia*)	6.7	25.4	2.7
Guayabochi (*Calycophyllum*)	2.2	30.2	3.6
Yesquero (*Cariniana*)	0.4	66.0	0
Uropi (*Claricia*)	2.6	23.3	13.6
Almendrillo (*Dipterex*)	0.2	99.0	1.8
Ochoo (*Hura*)	9.2	45.3	9
Negrillo (*Nectandra*)	4.7	20.4	30
Cedrilllo (*Spondias*)	4.1	39.5	4
Cafesillo (*Margaritaria*)	7.3	29.8	21
Coloradrillo (*Brysonima*)	8.6	19.6	71
Crespito (*Stryphnodendron*)	1.5	24.0	1
Sangre de Toro (*Virola*)	3.5	24.7	3.6
Coquino (*Pouteria*)	4.7	25	10.9
Total ~ 56 mean = 36.3			

Table 7.5: **Biomass Profiles.** Density (stems per hectare) and Mean DBH of tree species in different use categories in communal (C) and family (F) forest plots in three settlements along the Rio Chapare, Bolivia. The last column presents a verbal and pictorial representation of biomass or importance (a combination of Density and DBH data). For example, the species Hura crepitans shows an increasing value in density and mean DBH across a row (by settlement) and is thus represented by the pictograph (_ - ˙). This profile fits our predictions for market exploitation. In cases where density and DBH appear to decline in family forests in both Missiones and Santa Anita, the term "family use" is placed in the major effect column.

A. Commercial timber species

	Missiones				Trinidadcito		Santa Anita				Result
	Density		DBH		Density	DBH	Density		DBH		Major effect
	C	F	C	F			C	F	C	F	
Cedrela sp.	0	0	0	0	1	16	0	0	0	0	Depletion _ _ _
Dipterex odorata	1	0	150	0	1	48	0	0	0	0	Depletion _ _ _
Guarea sp.	14	12	17	22	15	20	7	9	23	13	Moisture ˙- _
Hura crepitans	5	7	42	45	12	51	7	13	30	57	Market _ - ˙
Swietenia macrophylla	0	0	0	0	0	0	0	0	0	0	Depletion _ _ _
Terminalia amazonica	9	12	36	22	5	57	8	5	50	114	Market _ - ˙

B. Traditional timber species

	Missiones				Trinidadcito		Santa Anita				Result
Species	Density		DBH		Density	DBH	Density		DBH		Major effect
	C	F	C	F			C	F	C	F	
Annona sp.	5	9	55	26	6	57	2	0	27	0	Moisture ˙- _
Brysonima indorum	19	9	18	16	6	19	13	5	32	117	Family use
Calycophylum sp.	3	1	30	17	3	30	1	0	49	0	Family use
Carinianana estrellensis	0	1	0	61	1	71	0	0	0	0	Rare or depleted

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Table 7.5B (continued)

	Missiones				Trinidadcito		Santa Anita				Result
Species	Density		DBH		Density	DBH	Density		DBH		Major effect
	C	F	C	F			C	F	C	F	
Ceiba pentandra	1	0	92	0	0	0	0	0	0	0	Rare or depleted
Claricia racemosa	2	2	18	25	4	32	1	2	21	20	Population _ - _
Margaritaria nobilis	8	13	25	23	8	27	7	4	12	21	Similar - - -
Nectandra sp	7	4	26	21	5	22	7	16	2	17	Family Use
Ocotea sp.	1	3	19	33	3	21	0	1	0	10	Moisture ˙ - _
Pouteria bilocularis	1	0	14	0	7	29	1	1	36	19	Family use
Pouteria sp.	3	1	26	15	0	0	0	10	0	10	Moisture ˙ - _
Stryphnodendron sp.	1	1	13	22	1	23	1	1	21	31	Similar _ _ _
Virola peruviana	15	17	25	17	13	22	0	0	0	0	Moisture - - _
Virola sebifera	5	1	26	20	0	0	14	17	19	33	Family Use

C. Tree species with traditional use for fruits (F) and medicines (M)

	Missiones				Trinidadcito		Santa Anita				Result
Species	Density		DBH		Density	DBH	Density		DBH		Major effect
	C	F	C	F			C	F	C	F	
Astrocaryum chonta (F)*	18	6	16	17	42	17	36	33	15	21	Population _ - _
Brosimum lactescens (F)	2	2	17	11	9	17	2	0	20	0	Population _ - _
Cordia nodosa (M)*	0	0	0	0	0	0	2	1	26	14	Market _ - ˙
Ficus insipida (M)	0	0	0	0	2	21	0	0	0	0	Population _ - _
Ficus sp. (M)	10	17	48	59	5	60	4	1	86	120	Moisture ˙ - _
Inga sp. (F)	44	37	20	19	17	18	14	12	18	21	Moisture ˙ - _

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Table 7.5C (continued)

	Missiones				Trinidadcito		Santa Anita				Result
Species	Density		DBH		Density	DBH	Density		DBH		Major effect
	C	F	C	F			C	F	C	F	
Leonia glycicarpa (F)	5	3	13	14	10	15	0	1	0	27	Other
Maclura sp. (F)	6	5	12	15	1	15	0	0	0	0	Moisture ‾ - _
Scheelea princeps (F)	5	1			23	9	13				Population _ - _
Sloanea rufa (M)*	1	0	20	0	1	19	6	4	20	17	Market _ - ‾
Spondias mombin (F)	4	2	43	21	5	45	4	4	51	37	Similar - - -
Theobroma cacao (F)	1	2	19	13	5	16	26	15	15	15	Other
Theobroma speciosum (M)	5	2	14	19	11	18	5	1	12	12	Population _ - _
Triplaris americana (M)	5	4	13	15	2	16	0	0	0	0	Moisture ‾ - _

***Also used for building materials.**

Commercial timber species had smaller diameters than fruit trees despite their low regeneration statistics (Figure 7.6). No fruiting species showed indications of depletion, while traditional timber species did. This suggests that sustainable stewardship is directed to those species that directly contribute to the Yuracaré food chain, while timber species are not managed as intensely.

Discussion and conclusions

The distribution and abundance of tree species along the Rio Chapare reflects moisture gradients, population pressure, and market demand in predictable ways. It thus seems possible to detect single factors that are determining the abundance of a variety of species along a river gradient and to determine when social processes outweigh ecological ones.

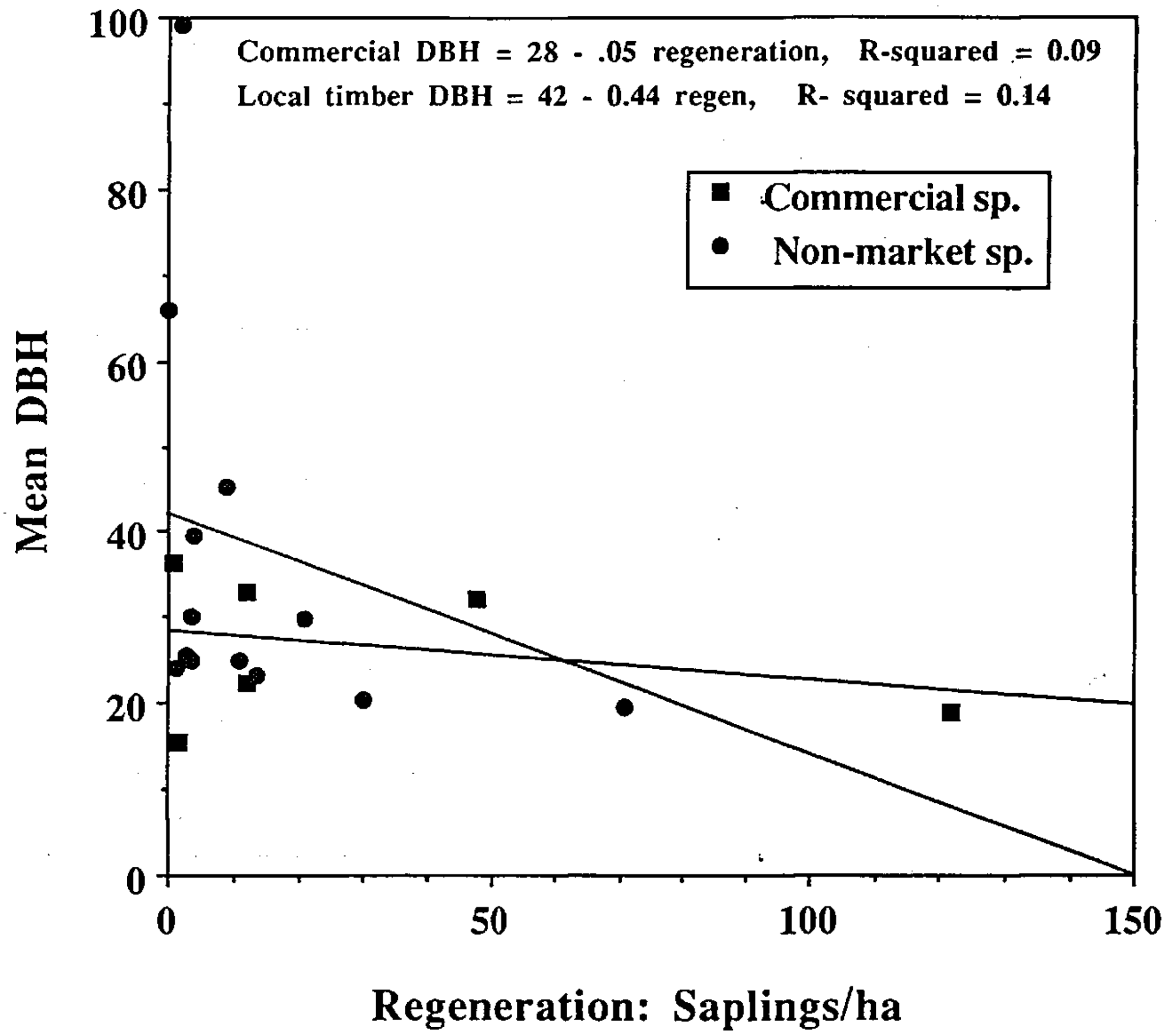

Figure 7.6: Linear regression of mean DBH on regeneration. Commercial species appear to be less conserved than noncommercial species. Species with poor regeneration value and no market pressure appear to be left to attain very large diameters before they are harvested, while commercial species lack this trend (see Table 7.5 for details of different species).

The results of this study refute the idea that the Yuracaré lack forest management institutions. In addition to cultural norms that prevent destruction of important forest resources, encourage activities that conserve or restore forest resources, and define boundaries and access to forest resources, the Yuracaré make and modify rules for forest use (Ostrom, 1990). They also monitor physical condition and use of forest resources, and sanction abuse of, and resolve conflicts over, forest resources. Clearly, the Yuracaré have constitutional, collective action, and operational activities that explicitly pertain to forest management, and their forest management system existed well before external government forestry agencies began to demand forest management plans. The Yuracaré also have language and traditions that would be considered hallmarks of sustainable forest management: long-term planning and constraints on individual use.

All along the Rio Chapare the Yuracaré have reduced tree density and diversity, but their selection for large fruiting trees has increased basal area and biomass. Because fruit abundance is positively correlated with basal area and dbh (Leighton and Leighton, 1982), Yuracaré forest management should enhance resources for wildlife. Essentially, their traditional forest management is a mutualism with fruiting trees and game animals. The Yuracaré increase the reproductive success of fruiting trees which increases the density of game, which has potential to increase Yuracaré survival.

While their long history of self-organization has helped them respond efficiently to recent incentives for timber exploitation, their tradition of conservation of fruit trees has not been extended to timber management. While they are capable of integrating with government forestry agencies to negotiate harvest quotas and constraints on harvest technology, they show little inclination to conserve or restore timber species. Perhaps it is just too early to judge, but our data suggest that several species have been extirpated in the entire region, and that extirpation of traditional species is now occurring around Missiones where market demand and alternatives to traditional cultural patterns are greatest. Traditional interest in fruiting trees and dependence on forest resources is changing.

Paz (1991) suggested that timber extraction would have negative consequences for the Yuracaré because the loss of timber species might cause a collapse in traditional resources used for subsistence. Presumably, Paz was thinking about the breakdown of potential ecological links between timber and fruiting species that sustain wildlife habitat and other important mutualisms (i.e., pollination, dens for game animals, etc.). At first glance, a collapse in forest resources seems unlikely because the Yuracaré appear to be maintaining fruiting trees and other trees that sustain their valued food chain and traditional needs. Their "mobile multiple use" system also buffers them against depletion of common-pool resources in the forest. Upon closer inspection, however, our results support Paz's conjecture. The parasitic relationship of timber exploitation is beginning to erode the Yuracaré's mutualistic relationship. Biomass and diversity are being lost as market and institutional incentives favor the unsustainable harvest of timber species. Privatization of forest resources may also promote a more sedentary life, which can put more pressure on resources as was shown by differences in forest condition at Trinidadcito and the permanent settlements.

Missiones, where population and market pressures are greatest, showed the greatest declines in basal area and abundance of individual species relative to other forests studied on the Rio Chapare. As more Yuracaré turn from hunting and tending forest gardens to embrace market economies and timber management incentives, the fruiting forest appears to play less of a role in their culture and language, and timber producing forest becomes more important. Given this change, forests along the entire Rio Chapare could become as degraded as those around Missiones.

While Yuracaré folk ecology refutes our null hypothesis, this does not imply that indigenous people have all the knowledge and institutional capacity required to manage forest resources. In this case, conservation end points were only convergent for certain tree species (fruiting trees). Ecological cognition appears to prompt the Yuracaré to be more risk adverse toward substitutions for fruiting species, while they seem less adverse to liquidation of many timber species. Timber harvesting has tested Yuracaré tradition and deserves more study from a socioanthropological context. For example, it is not clear how the different forest associations have resolved conflicts over privatization of timber species, or if any of the clans will institute a system of sustained-yield harvesting for timber trees. Given their traditional biases, they should monitor regeneration and focus timber exploitation on nonfruiting species that regenerate well.

Comparisons of colonial and indigenous settlements in the Amazon have consistently shown that forest degradation is typically greater under stewardship of colonial farmers than under the care of forest-dwellers with a long history of interacting with forest resources (Rudel, 1993; Chernala, 1989; Atran et al., 1998). Encouragingly, some colonists in the Peten of Guatemala have adopted ecological values and actions of forest-adapted Itzaj Mayans rather than dissuading the indigenous people from forest sustaining practices (Atran et al., 1998). Atran optimistically interprets this finding as potential for indigenous knowledge to influence policy and planning at regional and national levels, and advocates that co-evolved relationships between indigenous people and forest species should be considered more carefully by policymakers.

The Yuracaré have not fully evaluated the possible negative consequences of forest degradation, nor have they evaluated the bargaining power that might result from conserving their trees. The increase in basal area or biomass resulting from traditional Yuracaré forest management can be viewed as a positive contribution to carbon storage, which is a global commons benefit. Ecological cognition and values of the Yuracaré seem to be somewhat limited to trees that form the base of their food pyramid, yet their system has sustained people, wildlife, and a diverse forest for many centuries. Timber extraction has had negative impacts on both carbon storage (basal area) and biodiversity, and a forest policy based on commercial timber threatens the sustainable aspects of a 400-year-old relationship between people and forests along the Rio Chapare. Regional planners in Bolivia and external agents promoting timber harvesting need to make a more careful evaluation of the environmental impacts they are having on the mutualistic strategies inherent in the traditional Yuracaré forest management.

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Chapter 8

Coping with Changes in Population and Forest Resources: Institutional Mediation in the Middle Hills of Nepal

George Varughese

Introduction

Projections of massive declines in Himalayan forest cover and dire predictions for the future of forests in Nepal initiated worldwide concern in the 1970s (Eckholm, 1975, 1976; World Bank, 1978). Initially, the source of the problem was seen as domestic fuelwood use compounded by rapid population growth. Then, expansion of agriculture, commercial logging, and tourism were blamed. However, the actual rates of deforestation, as well as its causes and consequences, remain very much in question. More than one study has indicated that while there is degradation from overharvesting in the hills, the total loss of forest cover has been relatively small (for example, Ives and Messerli, 1989). Others argue that losses have even been reversed in both forest area (HMG, 1988; Bajracharya, 1983; Metz, 1990; Gilmour and Nurse, 1991) and tree density (Messerschmidt, 1986; Gilmour and Fisher, 1992). Still others contend that while forest area is not decreasing in the hills, the quality of existing forests is suspect (Chakraborty et al., 1997; Subedi, 1997).

This debate notwithstanding, the future remains uncertain and worrisome for Nepal's rural majority who depend upon forests. Even though the claims of dire environmental crisis might have been exaggerated, rising population, migration, increased industrial and commercial activity, and developmental pressures continue to place heavy demands on the forest resource base. In a country where over 80 percent of the population depends entirely upon agricultural and forest products for food, fodder, and fuel, forested lands always face the risk of being used at an unsustainable rate. Consequently, the issue of how to best govern forest resources in Nepal remains of critical concern to policymakers.

Population change lies at the heart of this debate, as it does for resource management and development policy globally. While for many population growth is accepted as a primary or intermediary cause of resource degradation (Ehrlich and Ehrlich, 1991; Brown, Wolf, and Starke, 1987; Bilsborrow and DeLargy, 1991), for others an increasing population is a stimulus to economic development and innovative resource management practices (Boserup, 1965, 1981; Simon, 1981, 1983, 1990; Binswanger and Pingali, 1989). In general, it has been difficult to find agreement on what the relationship is between population growth and natural resource condition.

This study examines the relationship between the governance of forest resources and population in the middle hills of Nepal. Specifically, it investigates the significance of local institutions in forest resource management to gain a better understanding of how such institutions shape the actions of individuals at the community level. By focusing on local institutions, this study becomes less concerned with what or who is the agent of environmental degradation than with what has helped forest users to cope with environmental and population change. Indeed, for the 18 locations in this study, the findings indicate that change in forest conditions is not significantly associated with population growth. Rather, change in forest conditions is found to be strongly associated with local forms of collective action. This implies that policymakers' preoccupation with population growth as a primary determinant of resource degradation may be ill-advised. Instead, the facilitation of institutional growth and innovation at the local level may be more relevant to the robustness of the natural resource base.

The first section of this chapter provides a general overview of the ongoing debate about the relationship between population growth and the environment. This overview provides the backdrop for a review in the second section of research that addresses forest resources in Nepal. The third section provides a description of the research setting and the approach used to conduct the study. The fourth section introduces the variables used for the study and reports the findings for the 18 locations. The fifth section provides a closer look at a set of six cases selected to understand differences in physical outcomes across the 18 locations. The chapter concludes with a discussion of some of the key factors that help explain differences between communities that have coped with population and resource change.

Population and the environment

A great deal of research has focused on the relationship between population change and the environment, and the debate continues. Since Malthus, scholars have argued forcefully that population growth is the primary cause of environmental degradation (Abernathy, 1993; Brown, Wolf, and Starke, 1987; Ehrlich and Ehrlich, 1991; Myers, 1991; Wilson, 1992). While demographers in this tradition have shown that population growth has some negative consequences, others have shown that population growth can also lead to technological advances and innovative uses of natural resources (Simon, 1983, 1990; Boserup, 1965, 1981; Binswanger and Pingali, 1989). Increasingly, research addressing the relationship between population change and the environment demonstrates that their linkages are complex and yet to be understood fully (Bilsborrow and DeLargy, 1991; Cruz et al., 1992; Jolly, 1994; Netting, 1993; Shivakoti et al., 1997). While it is clear that demographic change does influence resource use, population growth is but one variable of a larger set of important variables whose numerous interactions affect the natural resource base.

Part of the difficulty in understanding the linkages between population change and the environment is that, methodologically, much of the extant research examines agents of environmental change at a high level of aggregation. By resorting to a macro perspective, most of these studies have handicapped their ability to exploit micro-level research to understand the complex workings of population and environment linkages (Arizpe, Stone, and Major, 1994). Scholars of microinstitutional solutions to commons problems have long argued that local communities can craft durable institutional arrangements that enable them to manage successfully local natural resources, even when confronted with political, economic, and demographic pressures (Acheson, 1989; Feeny et al., 1990; Ostrom, 1990). These scholars recognize, however, that successful local solutions are more difficult to achieve where (1) demographic change is rapid, (2) a local community is not dependent on the resource in question, (3) substantial heterogeneities of interest exist, (4) little local autonomy exists to make and enforce rules, and (5) the resource system itself is very large (see, for example, Ostrom, 1998b). Thus, studying how local communities cope with different kinds of population pressures is a major topic of theoretical and policy interest.

In more focused research on factors that mediate environment-population interactions in the Kumaon Himalaya of India, Agrawal and Yadama (1997) have argued that by studying microrelationships at the community level it is possible to gain an understanding of how variables such as population, economic growth, and forest area get aggregated at a macrostructural level. Their study of 275 rural communities finds that local institutions play a critical role in mediating demographic and socioeconomic influences.

This study explicitly recognizes that factors such as population change can influence resource use in a variety of ways. But, rather than be determinative of human behavior, the study investigates how resource users might craft institutional arrangements to cope with demographic and environmental forces.

Research on Nepal

The growth of population and its supposed effect on the Nepali Middle Hills has been the subject of several studies. The earliest and most influential was conducted by Eckholm (1975, 1976), who drew attention to population growth in the Nepali hills and rather tenuously linked it to "denuded hillsides" and "deteriorating environments" where "the pace of destruction is reaching unignorable proportions" (1975: 764-65). Subsequently, it was shown that this connection between an increase in population and catastrophe in the hills was simplistic and misleading (Bajracharya, 1983; Ives, 1987; Ives and Messerli, 1989; Mahat, Griffin, and Shepherd, 1986a, 1986b).

In addition to rapid population growth, government policies of nationalization in the 1950s and 1960s have been identified by most researchers as one of the main causes of deforestation. Placing the ownership of forests with the national government disrupted pre-existing and traditional practices of communal resource management. Since the government lacked sufficient manpower or resources to look after newly nationalized forests, what was once communally governed property became open to anyone to exploit. Traditional management practices that have endured and more recent innovative community forestry legislation, on the other hand, have been credited for enabling the forest conservation and regeneration that has taken place in the Middle Hills since the 1960s (Arnold and Campbell, 1986; Mahat, Griffin, and Shepherd, 1986a, 1986b, 1987a, 1987b; Messerschmidt, 1986; Griffin, 1988; Hobley, 1990; Exo, 1990; Gilmour and Fisher, 1992; Chhetri and Pandey, 1992; Dahal, 1994; Pradhan and Parks, 1995; Subedi, 1997).

Recent studies of Nepal's forest management practices have directed attention towards the importance of institutional arrangements and social mechanisms. Some researchers have pointed to the role played by local institutional arrangements in sustainable resource use (e.g., Gronow and Shrestha, 1991; Gilmour and Fisher, 1992), but none have undertaken a study of institutional arrangements and their mediating effects on resource conditions. In a similar vein, studies have incorporated some descriptions of institutional arrangements within detailed descriptions of forest user groups (Chhetri and Pandey, 1992; Dahal, 1994; M. Karki, J. Karki, and N. Karki, 1994; New Era, 1996). While this work represents progress in Nepali forestry research, there is a paucity of social scientific research that brings an institutional approach to the study of local forms of community organization in forestry.

While the population in the Middle Hills continues to grow close to an annual rate of 2 percent at present, its effects on the surrounding patchwork of forest land are not so clear. One reason has been the absence of longitudinal data on forest condition and forest use. Few researchers have studied the same location over time. One notable exception is the study conducted by Jefferson Fox (1993) in a Nepali village in the Middle Hills in 1980 and 1990. Fox found that forest conditions were improved substantially even though population density increased significantly over a period of ten years. Fox's finding had little to do with the dynamics of population parameters. Rather, changes in the authority of villagers to manage nearby forests, the construction of a road that reduced the costs of inputs needed to adapt traditional agricultural practices, and the provision of external help in the form of knowledge rather than financial aid, appeared to be the most important factors for improved forest conditions (Fox, 1993). Clearly, population parameters alone did not drive these outcomes.

Another reason for the lacuna in research on forest condition and use in Nepal has been the lack of consistently collected cross-sectional data (Subedi, 1997). Frequently, the inherent weaknesses of a study done in a single time-period can be overcome if a sufficient number of similar studies are done using the same research methodology and theoretical framework in a single time-period. This study seeks to address this gap in knowledge by looking at local-level information on demographic and forest parameters across several locations in the Middle Hills visited in a single time-period.

The study setting

The physiographic zone of the Middle Hills of Nepal provides the broad setting of this study. In the Middle Hills, the population is estimated at 8.4 million (45.5 percent) with a growth rate of 1.61 percent for 1981-1991 (Central Bureau of Statistics (CBS), 1995). (Nepal's total population was 18.5 million with an annual growth rate of about 2.08 percent for the same time period.) The population remains largely rural, with fewer than 10 percent of the total in towns and cities. Subsistence agriculture is still the main occupation, although villagers do not hesitate to supplement their livelihoods by entering the market economy whenever opportunities arise.

The rural population in the Middle Hills is mostly distributed in small villages or hamlets that are sometimes parts of larger, dispersed settlements. A common pattern of forest-land distribution in these hills is for small patches of forests to be scattered throughout larger areas of cultivated land. These are vital sources of fuelwood, fodder, and leaf litter for animal bedding and composting, especially in the winter months when agricultural residues are exhausted. In 1985-1986, forestland (of about 5.5 million hectares) accounted for a substantial proportion (38 percent) of the total land area (about 14.7 million hectares) in the country. The Middle Hills contained about 1.8 million hectares (32.6 percent) of forestland in this time period (HMG, 1988).

The change in use of forest resources in the hills has not been ascertained with any accuracy. However, a recent study of over 3,300 households in Nepal found that 93.7 percent of rural households collected firewood and 86.8 percent used firewood as cooking fuel. Of all the households collecting firewood, 25.3 percent collected from their own land, 12.5 percent collected from community forest land, 59.7 percent used government forest land, and 2.6 percent obtained firewood from other sources (Nepal Living Standards Survey-CBS, 1996). Evidently, nonprivate forest lands continue to supply the majority of firewood for households in the hills, upwards of 70 percent. The figures for community and government forest land usage are only useful in estimating nonprivate land use. Frequently what is officially government land is actually communal by use. The figures also do not supply acreage of various lands used for forest products. It could well be that the community forests and private lands are less used because of management regimes in effect.

Community forestry in the Middle Hills is being implemented through the administrative structure of the Department of Forests, facilitated by various donor-aided programs. These range in size from bilateral projects covering one or two districts, such as the Nepal-Australia Community Forestry Project and the Nepal-UK Community Forestry Project in seven districts, to the largest—the Community Forestry Development Project—which is providing funds for investment activities, by way of World Bank assistance, to 38 hill districts. The 18 sites included in this study are from districts in the Middle Hills, most of which have various sorts of community-based integrated development program activities, including the community forestry program of the Nepali government.

A study of 18 cases in the Middle Hills of Nepal

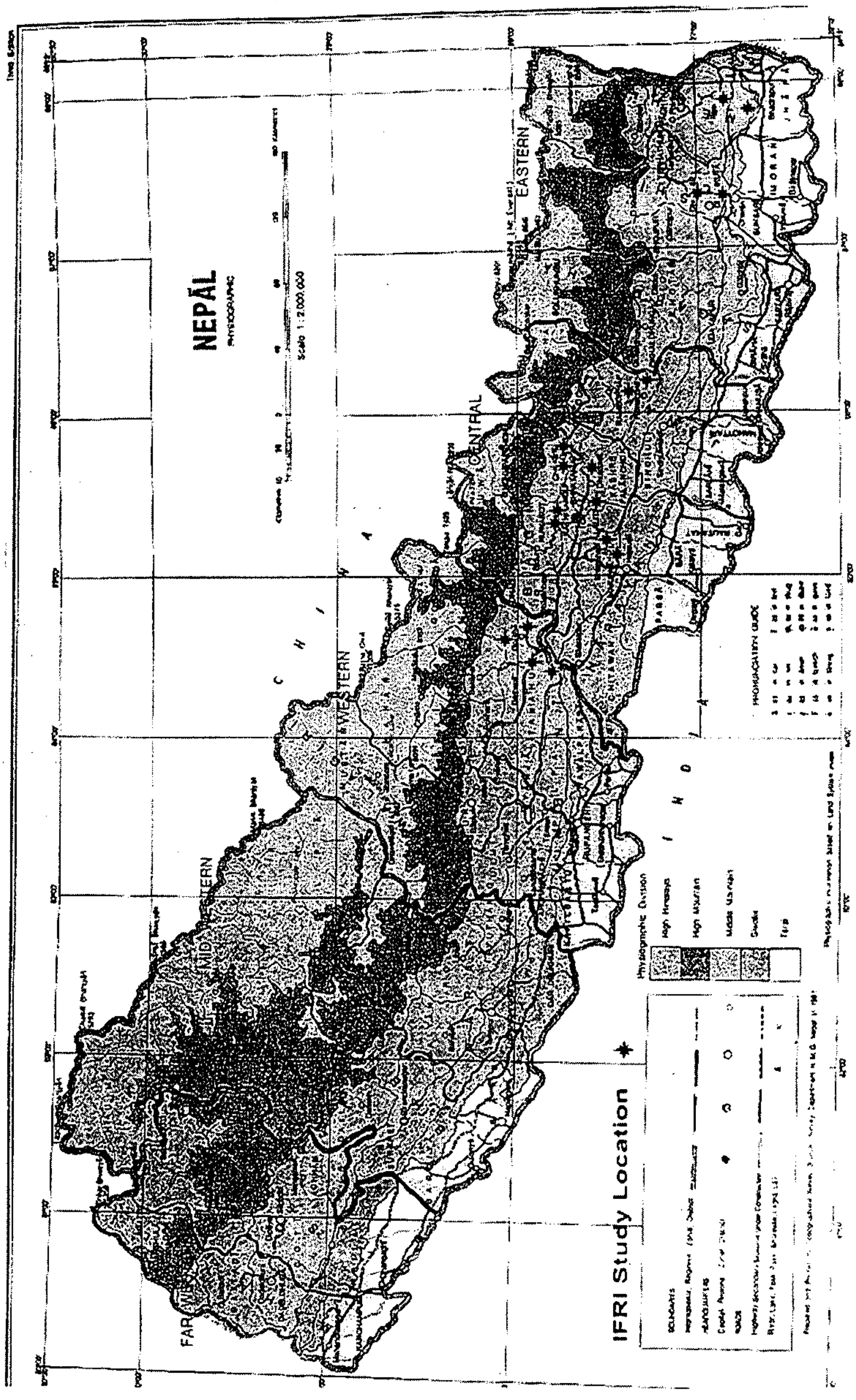
In order to examine the roles of institutions and population in forest resource change, this study employed a two-stage analysis. The first stage of analysis provides a broad understanding of trends in population changes and the association of these trends with (1) the perception of foresters and villagers of forest conditions (changes in tree density and in forest area) and (2) evidence of local-level organization and cooperation in resource management in the set of 18 cases. The second stage of analysis focuses in on six cases that help illustrate the patterns discerned in the initial analysis. The task is to identify and examine how the crafting and operation of institutional arrangements generate different outcomes.

The cases included in this study are shown in Table 8.1 in the chronological order in which they were visited by the International Forestry Resources and Institutions (IFRI) research program team in Nepal. These cases comprise a larger set of IFRI studies conducted in various physiographic zones of Nepal since 1992. The data for these particular cases were obtained over a period of three years. Each case was studied by a five-member team comprised of natural science and social science researchers over a period of four weeks using IFRI research methods (see Ostrom, 1998a; and Appendix I to this volume).

The 18 cases in this study represent locations within Village Development Committees (VDCs) in the Middle Hills of Nepal, and range from the easternmost district of Ilam in the Eastern Development Region to Gorkha and Tanahun districts in the Western Development Region (see Map 8.1). For the purposes of this study, the names of settlements are omitted and, instead, locations are identified using the names of the VDC within which the settlements and forests were studied. All but two of the studies (Manichaur and Sunkhani) conducted in the Western and Central Development Regions are part of a series commissioned by the Hills Leasehold Forestry and Forage Development Project of the government to monitor the effect of the project in those locations over time. As part of that monitoring plan, some of these locations have already been revisited since the first round of baseline studies; other locations are being revisited in the spring of 1998. The Manichaur and Sunkhani locations were studied as baseline assessments of forest use patterns in the Shivapuri Integrated Watershed Development Project north of Kathmandu valley.

In the Eastern Development Region, the cases are part of a longitudinal series of IFRI studies, funded by the MacArthur Foundation, that examine forest resources and institutions in locations that have varying access to markets and roads, and that are in areas of high and low intervention by government and donor agencies. Thus, the locations of study were mainly determined on the basis of project or agency criteria. However, the data obtained show variation on the factors I examine in this study—the indicators of population growth and change in forest conditions, and the degree of collectively organized activity by forest users.

The study initially uses descriptive indicators such as household and individual population, average household size, and forest area and stock condition to provide some idea of the locations visited (Table 8.1). In particular, the indicator **forest stock** provides a subjective assessment of forest condition at the time of the study by the forest specialists on the research team with respect to speciation and abundance of vegetation. This assessment also gives researchers an initial idea of the natural endowment that each group of users possesses. By itself, this assessment is not a good longitudinal indicator of forest condition, but when combined with some



Map 8.1: Eighteen locations in districts visited for IFRI studies

Table 8.1: Descriptive statistics for 18 sites

Site Location	Date of Visit	Population		Average Household Size	Forest Area (ha)	Forest Stock Assessment
		Individuals	Households			
Churiyamai VDC (Makwanpur)	March 1994	4500	750	6.0	85	Average
Baramchi VDC (Sindhupalchowk)	May 1994	244	36	6.7	75	Below Average
Riyale VDC (Kavre Palanchowk)	May 1994	644	92	7.0	29	Average
Bijulikot VDC (Ramechhap)	June 1994	980	145	6.7	53	Average
Thulo Sirubari VDC (Sindhupalchowk)	April 1995	843	105	8.0	16	Average
Doramba VDC (Ramechhap)	May 1995	139	26	5.3	107	Average
Agra VDC (Makwanpur)	June 1995	434	70	6.2	190	Average
Bhagwatisthan VDC (Kavre Palanchowk)	June 1995	471	70	6.7	108	Below average
Manichaur VDC (Kathmandu)	June 1996	1550	242	6.4	115	Average
Sunkhani VDC (Nuwakot)	September 1996	1065	144	7.4	290	Below average
Chhimkeshwari VDC (Tanahun)	December 1996	192	28	6.8	45	Average
Chhoprak VDC (Gorkha)	January 1997	781	106	7.4	25	Below Average
Raniswara VDC (Gorkha)	February 1997	2661	404	6.6	300	Average
Bandipur VDC (Tanahun)	February 1997	1021	183	5.6	75	Above Average
Barbote VDC (Ilam)	May 1997	1467	260	5.6	145	Average
Shantipur VDC (Ilam)	May 1997	162	29	5.6	90	Average
Chunmang VDC (Dhankuta)	June 1997	922	152	6.1	225	Average
Bhedetar VDC (Dhankuta)	June 1997	477	82	5.8	125	Above average

Forest Stock: assessed by forester based on tree density and speciation during period of study
Note: Names in parentheses are districts

measure of change in forest condition (see Table 8.2), one is able to obtain a general picture of resource use patterns and management.

Table 8.2: Preliminary comparisons of population growth with forest condition

Site Location	Population Growth Rate (%)	Households per Hectare (HH/ha)	Trend in Forest Condition
Doramba (Ramechhap)	7.37	0.24	Improving
Churiyamai (Makwanpur)	5.42	8.82	Improving
Shantipur (Ilam)	5.22	0.32	Worsening
Bhedetar (Dhankuta)	5.14	0.66	Worsening
Raniswara (Gorkha)	4.71	1.35	Improving
Chunmang (Dhankuta)	4.13	0.68	Worsening
Baramchi (Sindhupalchowk)	4.00	0.48	Stable
Barbote (Ilam)	3.64	1.80	Stable
Bijulikot (Ramechhap)	3.39	2.74	Improving
Riyale (Kavre Palanchowk)	3.00	3.17	Stable
Sunkhani (Nuwakot)	2.68	0.50	Worsening
Bhagwatisthan (Kavre Palanchowk)	2.60	0.65	Worsening
Chhoprak (Gorkha)	2.55	4.24	Worsening
Manichaur (Kathmandu)	2.28	2.10	Improving
Thulo Sirubari (Sindhupalchowk)	2.11	6.56	Stable
Bandipur (Tanahun)	1.44	2.44	Improving
Agra (Makwanpur)	0.29	0.37	Worsening
Chhimkeshwari (Tanahun)	-1.33	0.62	Stable

Forest Trend: assessed by villagers based on local historical understanding

At the time of this study, forest data from revisits to several of these locations were still being compiled and, therefore, the indicators used here for forest condition are limited to those based on assessments made by villagers and foresters. In other IFRI studies, more rigorous measures of vegetative stock are used in addition to measures based on assessments by villagers and foresters (see, for example, Becker, Banana, and Gombya-Ssembajjwe, 1995; Varughese, forthcoming).

In the 18 locations studied, household and individual population, average household size, and forest area exhibited considerable variation (Table 8.1). The number of individuals in a group of forest users varied from 139 to 4,500 and the number of households per group varied from 26 to 750. This gives a range of average household size across the sites studied to be from 5.3 to 8 individuals per household. The average household size across all 18 locations is 6.43 individuals per household. In comparison, a recent survey by the Central Bureau of Statistics (CBS) on Nepal Living Standards found the average household size to be 5.33 in this physiographic zone (CBS, 1996). The area of forest land used as a primary source of forest produce by villagers in these locations varied from 16 hectares to 300 hectares with an average across sites of 116.56 hectares. The condition of most of these forests was found to be within the average range in this physiographic zone. Only two locations had above-average stocks and three had below-average stocks. This assessment is made relative to typical forest stocks to be found in this zone as determined by the Department of Forests.

Table 8.2 provides comparisons of population **growth rate**, average **households per hectare of forest** area, and **trend in forest condition**. The population growth rate is obtained by taking the difference in households from the time of the visit to five years prior and averaging it over five years. The five-year rate is preferred here because the assessments of forest condition in this study are also based on a five-year period. The ten- and twenty-year growth rates were also available but are used only to supplement the discussion. The trend in forest condition is a subjective assessment of forest condition derived from the historical perceptions of diverse local forest users about the relative abundance of produce, disappearance of valuable species, and change in forest area: "worsening" indicates a clear depletion of species and reduction in forest area; "improving" indicates at least a perceptible increase in abundance of tree species and shrubs. The locations are arrayed from high to low rates of population growth in Table 8.2.

Table 8.2 is more useful in understanding changes for each site and provides some interesting findings. In general, the population growth rates (averaged over five years) vary from a negative growth rate of -1.33 to well over 7 percent per annum with a range of 8.70 and a mean of 3.26 percent per year. For a 10-year period, the growth rates vary from 0.37 to 10 percent per annum with a range of 9.63 and a mean of 4.08 percent per year. It is important to note that these growth rates are well above the national average for this physiographic zone, calculated to be 1.61 in 1991 (CBS, 1995). The household-to-forest ratios in these locations also exhibit dramatic variation, from 0.24 to 8.82 households per hectare of forest area with an average of 2.10 households per hectare. These figures show that there can be considerable variation from place to place in demographic characteristics across a physiographic zone.

However, is this variation reflected in forest condition? Across the 18 locations, there are six forests in improving condition, five in stable condition, and seven in worsening condition. But, if the growth rate is taken as a first demographic measure, the two highest rates (7.37 and 5.42) seen in Doramba and Churiyamai have a forest stock that is average and improving. The lowest rates (-1.33 and 0.29) seen in Chhimkeshwari and Agra have a forest stock that is average in condition but is stable (in Chhimkeshwari) or worsening (Agra). Furthermore, if the number of households per hectare of forest available is taken as a second indicator, the two highest ratios (8.82 and 6.56) seen in Churiyamai and Thulo Sirubari, respectively, have an average forest stock that is improving (Churiyamai) or holding stable (Thulo Sirubari). The two lowest ratios (0.24 and 0.32), in Doramba and Shantipur, are associated with an average stock that is either improving (Doramba) or worsening (Shantipur).

Furthermore, Table 8.3 indicates that there is little association between forest condition and population growth for these 18 communities even though they experienced higher growth rates than others in the region. The tau measure of association between the two variables is quite low at 0.24. Over 65 percent of improving forests are seen in locations with above-average population growth and over 55 percent of worsening forests are seen in locations with below-average population growth. These data demonstrate that a simple negative relationship between population growth and forest condition does not hold for these 18 cases.

Table 8.3: Association of population growth with forest condition

	Population Growth		
Forest Condition	Above Average	Below Average	Total
Improving	4 (66%)	2 (33%)	6 (100%)
Stable	2 (40%)	3 (60%)	5 (100%)
Worsening	3 (43%)	4 (57%)	7 (100%)
Total	9	9	18

tau (τ) = 0.24

This brief comparison illustrates a simple point: explanations of forest condition that rely primarily on population pressure may be too simplistic. The entire range of forest conditions can be seen to be associated with high or low values of demographic indicators. Clearly, demographic variables by themselves do not appear to explain forest condition satisfactorily. Two pertinent questions emerge from this finding: (1) how is it that some forests are in better condition in locations where population growth and population density per unit area of forest is high? and (2) how is it that locations with low population growth and density have deteriorating forests?

A look at Table 8.4 shows the association of trend in forest condition with a different kind of measure. This measure, called **degree of collective activity**, indicates the extent to which local residents have organized themselves to manage forest use. The degree of collective activity is derived from a set of questions that ask whether there are rules (formal and informal) related to entry into a forest, harvesting in a forest, and monitoring of a forest, and how the group organizes its forest-related activities.

A low degree of collective activity is noted for cases where individuals are aware of forest degradation and resource scarcity and observe harvesting constraints on their own, without any group-level activities or rules of harvest. For this study, I classify low collective activity along with no collective activity. A moderate level of collective activity is noted when a group of individuals have harvesting and entry rules, planned minimal forest-related group activities, but have little or no monitoring of rule breakers. A high level of collective activity is noted when a group of users have harvesting and entry rules, monitoring by members, and organized forest-related group activities. These, of course, comprise just a small portion of the repertoire of rules that may exist at any location and are used here as minimum indicators of collective activity. The locations in Table 8.4 are arrayed according to the trend in forest condition observed, from improving to worsening.

In Table 8.4, five of the six improving forests are associated with high levels of collective activity, while one forest is associated with a moderate level of collective activity by users. All six had stocks that were at least average in condition for this physiographic zone. Four of five forests in stable condition have a moderate level of collective activity associated with them, while one has a low level of collective activity. Three of these stable forests have average stocks and two have below-average stocks. Six of seven forests in worsening condition had low or zero levels of collective activity by villagers, while one forest had villagers engaging in a moderate level of collective activity. Of these seven forests, one had above-average forest stock, three had average forest stocks, and three had below-average forest stocks.

Table 8.4: Preliminary comparisons of forest condition with collective activity

Site Location	Forest Condition Trend	Forest Stock Condition	Collective Activity
Churiyamai (Makwanpur)	Improving	Average	High
Bijulikot (Ramechhap)	Improving	Average	High
Doramba (Ramechhap)	Improving	Average	High
Raniswara (Gorkha)	Improving	Average	High
Bandipur (Tanahun)	Improving	Above average	High
Manichaur (Kathmandu)	Improving	Average	Moderate
Riyale (Kavre Palanchowk)	Stable	Below average	Moderate
Thulo Sirubari (Sindhupalchowk)	Stable	Average	Moderate
Barbote (Ilam)	Stable	Average	Moderate
Baramchi (Sindhupalchowk)	Stable	Below average	Low
Bhedetar (Dhankuta)	Worsening	Above average	Moderate
Agra (Makwanpur)	Worsening	Average	Low
Chhimkeshwari (Tanahun)	Worsening	Average	Low
Hunmang (Dhankuta)	Worsening	Average	Low
Bhagwatisthan (Kavre Palanchowk)	Worsening	Below average	Low
Sunkhani (Nuwakot)	Worsening	Below average	Low
Chhoprak (Gorkha)	Worsening	Below average	None
Shantipur (Ilam)	Worsening	Average	None

Collective Activity: organized collective action level at the user level
Low = individuals may observe harvesting constraint on their own, no group activities
Moderate = as a group, individuals have harvesting constraints, minimal group activities, little or no monitoring
High = enforced harvesting constraints, organized group activities, monitoring by members

A strong degree of association is evidenced by the tau measure of association for Table 8.5. A high level of collective activity related to forest management is seen in 83 percent of all forests that are improving in condition. In 86 percent of locations where forests were found to be deteriorating, there was little or no collective activity being undertaken by the local community. In the majority of locations where the forest resource was seen to be neither deteriorating nor improving, i.e., stable, the users were engaged in at least moderate collective action.

Table 8.5: Association of level of collective activity with forest condition

	Collective Activity			
Forest Condition	High	Moderate	Low or None	Total
Improving	5 (83%)	1 (17%)	0	6 (100%)
Stable	0	3 (60%)	2 (40%)	5 (100%)
Worsening	0	1 (14%)	6 (86%)	7 (100%)
Total	5	5	8	18

tau (τ) = 0.80

Discussion of selected cases

For almost all of the locations in this study, the level of collective activity undertaken by users is found to be positively associated with forest condition. To understand the mechanisms that lie behind these positive associations, this section examines in greater depth two cases for each type of forest trend observed (Table 8.6). These cases are selected because they are representative of the larger set in terms of the variance of the factors to be examined and because their case histories provide the most salient detail for the purposes of this study (IFRI, 1995, 1996, 1997a, 1997b).

Improving forest conditions

Raniswara. This location is marked by large settlements, a high level of population growth, and fluctuating migratory patterns. It is also very close to the bustling Gorkha bazaar, the major commercial center in the area. The residents of this VDC have one of the most successful, nationally recognized, active and well-endowed community forest associations. There are 11 settlements around a large forest (300 ha), with all but two divided along caste lines. There has been no external intervention to speak of in this area; villagers regard the government neither as a source of support nor of hindrance.

Table 8.6: Cases selected for discussion

Site Location	Population Growth (%)	Households per Hectare (HH/ha)	Forest Stock	Forest Condition	Collective Activity
Raniswara (Gorkha)	4.71	1.35	Average	Improving	High
Churiyamai (Makwanpur)	5.42	8.82	Average	Improving	High
Riyale (Kavre Palanchowk)	3.00	3.17	Below average	Stable	Moderate
Barbote (Ilam)	3.64	1.80	Average	Stable	Moderate
Agra (Makwanpur)	0.29	0.37	Average	Worsening	Low
Chunmang (Dhankuta)	4.13	0.68	Average	Worsening	Low

The forest association for this group of users was formed informally seven years ago (with no prior history of organizing in this manner), and legally registered two years later, making it the oldest registered group in the district and one of the oldest in the country. The primary reason for forming the association was to initiate an organized way of protecting a completely denuded hillside—the result of prolonged government neglect, overuse by locals, and land grabbers. In time, the area protected increased and the association has now petitioned the forest office to add an additional 125 degraded hectares to the forest area. In anticipation of a positive response they have initiated planting and protection of seedlings. Forest products are plentiful but consumption is strictly regulated by the association. Although timber trees are abundant, the annual consumption of timber is being reduced and closely monitored. Very minor infractions take place. Most of the users have switched to using privately grown fodder trees and agricultural residue for their stall-fed cattle, although grass may be cut from the forest floor at all times. Less and less agricultural land is being used for staples because most of the youth labor force is in school. Many farmers are experimenting with fruit trees and vegetables.

This forest association has fashioned several innovative solutions to day-to-day forest-related problems. To deal with political partisanship (which is wrecking many user groups in Nepal), they have banned political discussions in any forum related to this association. To deal with their large numbers (over 2,600 individuals) they have created smaller subcommittees specifically oriented to reducing the load on the executive committee and enhancing their ability to cope with large, complex tasks. Users' households are divided along ward lines into subgroups for weeding and protecting the forest area closest to their settlements. To use their time most efficiently in forest-related work, users synchronize weeding, pruning, and coppicing activities with forest product allocation and distribution activities.

To monitor the use of valuable products such as timber, this association has an investigative subcommittee that monitors the amount requested for a particular use by a user, the amount granted by the association harvest subcommittee, and the ultimate use of the harvested timber by that user. During periods of high usage they increase the number of forest guards and patrols. To reduce the use of fuelwood, they give small grants to those who want biogas plants, enough to cover expenses incurred in addition to the available government subsidy.

The association has a regular outreach effort that encourages settlements near the borders of this association's forest to join this association or to form their own association. The rationale is that if currently unauthorized users were to become part of the association, costs related to monitoring and sanctioning would decrease for the association, and the pool of labor available for protection and maintenance activities would increase. If unauthorized users were to form their own association for forest land in their own areas, heretofore unprotected forest lands get protected and there are fewer occasions of unrestrained harvesting in surrounding forested areas. This forest association also regularly sends two trainers to participate in government-sponsored training programs that are held for fledgling forest associations in the region.

Churiyamai. This site is located about eight kilometers northeast of Hetauda municipality, the center of Makwanpur district, and is accessible by an all-weather road. The three settlements in this site comprise an informal forest association with a total of 750 households and 4,500 individuals. This association has a 19-member executive committee to manage their community forest of about 85 hectares. While agricultural production is comparatively low, most residents here have supplementary cash income from selling milk and some poultry. The milk-producing buffalo is stall-fed in all homes. Most of the other livestock is grazed in fields, bunds, and risers. Almost every household has someone working on an off-farm job in neighboring Hetauda or in Kathmandu. Twenty-five percent of the households also have a member working as seasonal labor.

The community forest has two distinct blocks, one of which is a 27-year old former government research tract and the other a tract initially developed by the Terai Community Forestry Development Program seven or eight years ago. In 1990, the households of the two proximate settlements formed a forest association with a committee to manage both blocks as one community forest. The third settlement disputed this arrangement because the villagers in this settlement were also traditional users and because some parts of the forest were within their boundaries. As a countermove, this settlement formed a forest association and committee for its own area of the forest. This arrangement was not satisfactory and led to conflicts over boundaries and membership between the three settlements. Resolution to the problem was reached by merging the two groups into one forest association and allowing all three settlements to avail of the entire forest area.

This larger group of users from the three settlements operates on an informal level and is yet to be registered as a forest association under community forestry law. However, they function as a well-organized association, with rules specifying entry, harvest of particular products, and times of harvest. Grazing and felling of live trees is prohibited. Collection of fallen leaves and grass is permitted upon payment of a fee. These fees and proceeds from sale of deadwood or fallen trees provide cash income for the association. The income is used to pay for two full-time forest monitors at present. These measures have considerably improved the condition of the forest. The association members also feel that once their application for formal recognition is accepted by the forest office, they will be able to further this improvement by implementing some forest management, plantation, and erosion control activities that they have planned.

The strict conservation practices have resulted in people planting fodder trees on private land and using a government forest that is almost two hours distant by foot. Residents have also increased their use of agricultural residue and grass from fields and roadsides to supplement animal feed requirements. Like Raniswara, this group has a large repertoire of enforced rules on entry and harvest and users have high levels of rule awareness and compliance. There are no plans to ease restrictions on cutting of tree fodder or felling of trees.

Stable forest conditions

Riyale. Three settlements with a total of 92 households constitute the users of a forest area of 29 hectares in this location in Riyale VDC. The forest is within a 20-minute walk of the settlements. There is a market 10 kilometers distant and accessible by a fair-weather road. This VDC is geographically close to Kathmandu valley, but residents have not taken advantage of their location to obtain agricultural inputs or exploit markets for their produce. There is a dairy cooperative nearby that obtains some of its milk supply from the residents of this group.

The forests in this area did not have an organized form of forest protection or management in the past. There was an increasing trend towards degradation until the late 1980s when mature trees of several valuable timber species were removed. As the forest area deteriorated, villagers started restricting their own harvest of timber as well as any use of their forest by outsiders. The local forest office underwrote a major plantation effort in 1992 and deputed a forest watcher for a period of five years to help monitor the plantation. It is uncertain whether this arrangement is to continue after that period. The forest association was legally recognized by the forestry office in 1994 but was not functional in its formal form until late 1995.

This forest association has been able to close the forest to grazing and harvest of tree products but allows collection of grass and deadwood. There have not been any efforts to raise funds for the association and, besides the initial plantation of saplings, members have not participated in maintenance and protection activities. This is the extent to which they have implemented their management plan. Activities like weeding, thinning, and pruning are planned but yet to be carried out. The presence of a government-paid monitor has reduced illegal activities but not stopped them. There are some violations of the timber harvesting, grazing, and tree fodder rules. However, there are no fines levied and no records are kept of violations.

The forest has not deteriorated since the association was organized in 1991. The general restriction on tree harvest and grazing, and the presence of the forest watcher, has resulted in some regrowth of natural vegetation.

Barbote. Barbote VDC of Ilam district is about a two-hour walk by all-weather road (40 minutes by bus) from Ilam Bazaar. This VDC contains a large forested area (120 ha) that has been looked after by a formally registered forest association for the last six years. There are nine settlements in the immediate surroundings with several others nearby. While the forest in this area did not undergo the rapid deforestation that occurred in central and west Nepal in the 1970s, there was a distinct period of time about 8-10 years ago when the forest had degraded. The forest improved after villagers started protecting the area. However, in the last three years or so, the forest has begun to show signs of degradation again, and villagers have begun to worry about the future availability of supplies of timber, fuelwood, and fodder.

The community forest boundaries have not been demarcated at any time; a rough estimate was made at the time of the formation of this association. There are many members of this association who dispute the existing boundaries of the community forest. These members have maintained agricultural plots within or encroaching upon existing forest land. They hope to claim ownership over these plots if and when the community forest gets demarcated properly.

Population growth is stable with very little fluctuation. Most of the villagers have been here for five or six generations. The executive committee of this association has undergone some upheavals in the past two or three years owing to the resignation—on corruption charges—of the secretary and chairman. The users in the immediate vicinity are not very active but do participate in a bare minimum fashion that allows them to remain members.

There are more registered users than actual users—merchants in the nearby market are registered as members but in reality do not use the forest and do not help with any maintenance activities. Villagers point to this membership problem as the reason for the breakdown in cooperation. Falsely registered members outnumber actual members in the register and are able to affect quorum requirements for any change in rules, especially those related to membership. Thus, by their absence they guarantee their membership. When approached by executive committee members to help in the matter, the District Forest Office has stated that the forest was now a community forest and, therefore, unless the majority of users complains about a problem, the government can do nothing.

There is one member who acts as the organizer, facilitator, and adviser-at-large for this association. He mobilizes users from time to time for certain activities but now says that it has been getting harder and harder to get the association enthused about the community forest especially because of the membership and politics problems. As in Riyale, the users in Barbote also have rules constraining entry and harvest but there is no arrangement for regular monitoring and there are infractions that are not punished. Because of an ugly history of abuse of authority by office bearers of this association and, now, politics, there is always suspicion among the general body of users about the motives of any activity proposed by an office bearer. There is limited interaction between users and they rarely assemble in full strength. Decisions requiring general body agreement are not made, and in the case of Barbote, are almost impossible to make because of the difficulty in reaching the quorum requirement.

Worsening forest conditions

Agra. This site is within a half-hour walk from a national highway and market. The forest used is about 190 hectares within a 15-minute walk of the two settlements in the site. Residents of both settlements belong to the same ethnic group and religion and are the traditional users of the forest, although residents of neighboring villages are not barred from harvesting forest products in this forest. For a period of 18 years up to 1989, there was some system of forest protection by the villagers of the locale. In fact, from 1987 to 1989, the users had formed an executive committee to oversee forest management activities for the users of the two settlements in a formalized manner. In 1990, following the political upheaval in the country, this system broke down and there was no organized form of forest protection or use. Users got divided along party lines and few were willing to reconcile in the matter of resource protection and management. In 1993, villagers from the two settlements again defined a group of users for this forest and elected an executive committee with the objective of preventing tree felling by anyone and to stop neighboring villages from using the forest. This lasted until 1995 and then again dissolved because there was no agreement over the fines to be levied on rule-breakers.

Although there is no organized activity at present, the users of these two settlements have once again defined a user group for this forest, formed an executive committee, and drafted an article of association in preparation for being recognized by the district forest office. The neighboring villagers, however, are opposed to this limited user group and want to be part of it. The main reason these neighbors want to be members appears to be the presence of a slate quarry of 10-12 hectares that lies within the forest boundary closest to their villages. Several members of those villages have profited from the slate quarry until now and this important source of income would become off-limits once the proposed user group is recognized by the forest office. The application for the forest association is stalled at the forest office because of this opposition, partly because the license for quarrying slate was issued by the district development committee office, a higher-level authority.

Villagers of the two proximate settlements have appealed to the district soil conservation office to stop the slate mining because large-scale erosion is taking place at the site. The erosion gullies and runoff are destroying vegetation in the immediate forest area. In the meantime, valuable herbs are being harvested indiscriminately and sold to outside contractors, and unrestrained grazing and cutting of fodder takes place.

Chunmang. The site in this VDC is not very accessible: a steep downhill walk of three hours from the road head, Hile (at 2300 m), gets one to the site (between 600 and 900 m). The nine settlements in this location are scattered on the west-facing slope of a mountain; six settlements are closer to the area's forest and three settlements are farther away. All the settlements are situated higher than the forest area, which ends at the streambeds along the base of the mountain. The residents of this site live in settlements differentiated mainly along caste lines; all castes are present. One particular caste is dominant, politically and socioeconomically, by virtue of their numbers. The local representative to the political party in power is from this caste. They also have a loyal following of some members of lower caste, who depend on them for employment and land.

There has been discord over organizing these settlements to manage the nearby forest in the past several years, owing mostly to the various hindrances put up by the dominant caste. Of the nine settlements using this forested area over the last several decades, there is divided opinion over the options for managing the forest area. The users have been discussing variations of two options: (1) combine all nine settlements and form one association and one large forest area with different management units or (2) form two associations and split up the forest area according to relative distance to forest from settlements. Of the six settlements that are closer to the forest, two (led by the dominant caste) are unwilling to form a large association that combines both far and near settlements and utilizes the entire forest area. Their first proposal is to have one portion (the larger, more valuable forest) allocated to the six settlements and another portion (the smaller, more degraded) allocated to the three distant settlements, thus forming two associations with two separate areas. Their second proposal is simply to exclude the three distant settlements and form one association for the entire forest area. Neither option is acceptable to the three settlements because they see the allocation of forest area as unfair in the first case, and their complete exclusion from forest use as an insult to their traditional rights in the second case.

The opposition put up by the dominant caste members in one of the six proximate settlements has been frustrating to the more cooperative villagers who belong to other castes in these six settlements, especially because the forest is currently open to anyone for use. As a result, many areas in the forest are getting degraded, with other areas soon to follow. Most of these villagers are willing to form a single association with the three distant settlements, or even participate in an equitable apportioning of the forest land to two associations. Without some form of collective action, all agree, there will be problems in the near future regarding forest products.

This situation has also been frustrating for the staff of the district forest office who tried about four years ago to establish an association but were rebuffed in their efforts by the dominant caste. Since then, however, there has been no attempt by anyone outside these communities to try again. There are several individuals in and around the area who would like to assist in forming an association for this forest but these individuals say that they would like a third-party to act as an intermediary to mediate and give advice on other options for all these forest users. In the meantime, the forest is a source of timber, fodder, and fuel for all these settlements and even for some outsiders.

As in Agra (and Barbote), district officials have failed to act upon petitions in Chunmang. This lack of action has created uncertainty for the users and has helped opportunistic individuals take advantage of the lack of any organized form of forest protection to harvest timber and encroach upon forest land. In both Agra and Chunmang, villagers are aware of the deteriorating condition of their forest resources but no group activity is evident, partly because of factionalization of the community owing to politics and economic ties. However, there was a time in both locations when some form of organized activity had started and subsequently failed; both locations have had group building efforts by outside agencies four or five years in the past but none going on at present.

Conclusion

This study examined the relationship between population, institutions, and forest conditions in the Middle Hills of Nepal. The study indicated that the variation in population growth rates across the locations studied had almost no discernible correlation with the variation of forest condition in those locations. The study did, however, show a strong association between local collective action and variation in forest conditions across the 18 cases.

By identifying some of the characteristics of institutional arrangements used by villagers, this study sought to appraise an undervalued facet of the complex presentation of the population-environment dynamic. That local forest users can cope with perceived changes in resource condition and in user population is evident from the cases studied in this chapter. In the more successful cases, arrangements for identifying genuine users, determining harvest amounts and timing, and active monitoring by users themselves emerge as important factors in managing forest resources (Table 8.7).

Where users were unable to define the extent of forest boundaries or the number of users in a group clearly, the ambiguity allowed opportunistic individuals to encroach upon forested land. Investments in monitoring, in particular, significantly determine the difference between a flourishing resource and one just able to meet the needs of users. In the locations with higher populations but improving resources, Raniswara and Churiyamai, user groups invested in monitoring even to the point that extra guards were assigned during seasons of greater need. This finding follows a study by Agrawal and Yadama (1997) who, in their sample of 279 communities, found that the most important form of user participation was the level of investment by the user group in monitoring and protecting activities.

Much of the literature on collective action has discussed the negative association between group size and collective action. Yet, in groups such as in Raniswara, users had ways to deal with large numbers. The adaptation of user group structure by creating levels of subgroup activity was one way to deal with the increased complexity of tasks and the difficulty of coordination that is brought on by large memberships. This sort of innovation was facilitated at times by the village administration and forestry officials who participated in the meetings that assign duties and responsibilities to various subgroups.

Table 8.7: Some institutional characteristics of select cases

Site Location	Forest Condition	Institutional Characteristics		
		Entry and Harvest Restrictions	Monitoring Arrangements	Adaptive or Innovative Mechanisms
Raniswara (Gorkha)	Improving	Yes	Yes	Yes
Churiyamai (Makwanpur)	Improving	Yes	Yes	Yes
Riyale (Kavre Palanchowk)	Stable	Yes	Yes	No
Barbote (Ilam)	Stable	Yes	No	No
Agra (Makwanpur)	Worsening	No	No	No
Chunmang (Dhankuta)	Worsening	No	No	No

The group in Raniswara has also actively pursued the objective of increasing the area of forest they use by soliciting the membership of neighboring villages who, then, attach their adjacent forest lands to that of the group. Arranging for regular interactions between users, other villagers, and external parties in positions of authority and influence had the effect of reducing suspicion, facilitating information diffusion and raising awareness throughout the area, and garnering public support for management and conservation ideas. A breakdown in community relations and an undermining of collective organization and action was seen in Barbote, Agra, and Chunmang where the public was divided in its opinion (due to kinship, economic ties, allegations of corruption, and politics) and no third party was available (or interested) to mediate the conflict.

The World Bank has stated that "because the people who cut or plant trees typically *have no incentive* [emphasis added] for considering the environmental and social consequences of their actions, externalities inexorably lead to excessive deforestation and insufficient planting of new trees" (World Bank, 1991: 9). Such statements have been acted upon in the past with the result that disproportionately large funds have been allocated to reforestation and strengthening the administrative functioning of government forest offices. However, the findings of this study suggest a different direction and point of emphasis in policy research and application. The recognition of the mediating effects of local institutional arrangements in the population-environment dynamic has important ramifications for those who seek to support community forestry and, more generally, participatory approaches to governing natural resources. This study suggests that development policy aimed at preserving the environment must recognize the significance of institutional arrangements at the local level to resource conditions at that level. Ultimately, the benefits and costs associated with resource conditions at the local level have considerable bearing on larger environmental issues. Furthermore, the study suggests that government policy on participatory resource management will be more successful if it is facilitative of institutional innovation and adaptation at the village level.

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Appendix I

IFRI Research Strategy

Elinor Ostrom and Mary Beth Wertime

The International Forestry Resources and Institutions (IFRI) research program is a long-term effort to establish an international network of Collaborating Research Centers (CRCs) who will:

- continuously monitor and report on forest conditions, plant biodiversity, and rates of deforestation in a sample of forests in their country or region;
- continuously monitor and report on the activities and outcomes achieved by community organizations; local, regional, and national governments; businesses; nongovernmental organizations (NGOs); and donor-managed projects in their country or region;
- analyze how socioeconomic, demographic, political, and legal factors affect the sustainability of ecological systems;
- prepare policy reports of immediate relevance for forest users, government officials, NGOs, donors, and policy analysts;
- build substantial in-country capacity to conduct rigorous and policy-relevant research relying on interdisciplinary teams already trained in advanced social and biological scientific methods; and
- prepare training materials that synthesize findings for use by officials, NGOs, forest users, and students.

This Research Strategy was originally drafted in the initial planning phases of the project in 1994. It is appended to this volume of papers from the IFRI research program so that readers can understand the design of the overall program as well as the findings from some of the initial studies.

The problem

Drastic measures to halt the alarming rates of deforestation, especially in the tropical forests of Central and South America, Asia, and Africa, are regularly proposed by officials, scholars, and those concerned with environmental issues. The term "crisis" often appears in the titles of scientific reports.[1] Noted scholars speak about "catastrophes about to happen,"[2] or "mass extinction episodes" (Myers, 1988: 28). Indeed, projected rates of population growth, deforestation, and species loss are startling:

- The world's human population is predicted to be 10 billion by the year 2025 and 14 billion by the year 2100.[3]
- Most tropical forests "will be entirely lost or reduced to small fragments by early in the next century."[4] "[P]rimary ancient forest areas are being destroyed at accelerating rates. At best, they are replaced by secondary forests which offer impoverished biodiversity, and, at worst, they are taken over by desertification."[5]
- One quarter to one half of the earth's species will become extinct by 2020.[6]

These losses are often attributed to a set of causes that appear to vary depending on institutional affiliation, academic persuasion, or business/economic concern. Many individuals and environmental groups view commercial logging as the cause of deforestation.[7] Shifting or new cultivation is viewed as the primary cause by scholars in other narratives.[8] Excessive energy consumption is cited by others. Population increase is considered by many to be a prime candidate causing deforestation and other environmental harms.[9]

A singular view of the cause is frequently paired with a singular view of the solution. Preservationists have often addressed the problem through "save and preserve" solutions. Maintaining the position that strict actions must be taken to preserve the old-growth forests and the diversity of plant and animal life, proponents of

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[1] *For example, see Wilson (1985), Task Force on Global Biodiversity, Committee on International Science (1989).*

[2] *Bruce Cabarle, Manager of the Latin America Forestry Program at the World Resources Institute, recently commented: "There really is a catastrophe waiting to happen, both for the forests and the people who live off them" (in Alper, 1993).*

[3] *United Nations Population Fund (1989) projections based on current levels of birth control use. The estimated population in the World Bank's World Development Report (1993: 268-69) for 2025 is, however, a more modest 8.3 billion. It is not unusual to find discrepancies this large in projected population figures given different assumptions about initial starting conditions and rates of change.*

[4] *Task Force on Global Biodiversity (1989: 3).*

[5] *Chichilnisky (1994: 4).*

[6] *See Lovejoy (1980), Ehrlich and Ehrlich (1981), and Norton (1986). Reid and Miller (1989: 37-38) estimate that between 1990 and 2020, between 5 to 15 percent of all species would be lost.*

[7] *Task Force on Global Biodiversity (1989: 3); see also discussion in Ascher (1993).*

[8] *"It is this broad-scale clearing and degradation of forest habitats [by communities of small-scale cultivators] that is far and away the main cause of species extinctions" (Myers, 1988: 29).*

[9] *For very recent views stressing the primary and simple role of population increases see Rowe, Sharma, and Browder (1992: 39-40), Abernathy (1993), Fischer (1993), Holdren (1992), Ness, Drake, and Brechin (1993), and Pimental et al. (1994).*

this argument push for protected areas where certain activities, such as logging, are prohibited and species such as the spotted owl are protected.

Policy analysts often recommend changes in international agreements or shifts in national policy as a solution. At the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in June of 1992, three major policy documents were produced at the conference (the Rio Declaration, Agenda 21, and the Forest Principles) and two conventions released for signature (the Convention on Biological Diversity and the Convention on Climate Change). All of these documents proposed the adoption of international standards to regulate the use and management of natural resources—particularly forest resources, so as to enhance their diversity and sustainability over time.[10]

National governments have adopted government and industry reforestation schemes, forest-based industrial developments, and forestry action plans. National policies range from changing forest commons into private land, assigning governments the responsibility of managing reserves and severely limiting access to these reserves, or prescribing community nurseries of pre-determined tree species in rapidly changing environments—without regard for indigenous people, their changing environments, and methods of management of forest resources.

Agreement seems to exist about the need for immediate action. Less agreement exists about which policies will lead to actual improvements. A common theme in the evaluations of national and international efforts to stem the rates of deforestation is that many of these programs actually "accelerate the very damage their proponents intend to reverse" (Korten, 1993: 8).[11]

If the programs that are supposed to stem deforestation tend to accelerate it, something is wrong! The IFRI research program will attempt to ascertain what is wrong and provide better answers to the question of how to reduce deforestation and loss of biodiversity in many different parts of the world. In our efforts to understand what is wrong, we have identified three problems: (1) knowledge gaps, (2) information gaps, and (3) the need for greater assessment capabilities located in countries with substantial forest resources.

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[10] The "Houston Communique" issued in 1990 is also relevant. See description in Sedjo (1992: 16).

[11] Korten is summarizing her evaluation of the impact of a "showcase loan" by the Asian Development Bank to support the reforestation of 358,000 hectares of land in the Philippines. Similar evaluations have been made of many national and international efforts (see, for example, Arnold and Stewart, 1989; Sen and Das, 1987; Apichatvullop, 1993; Shanks, 1990; Chambers, 1994; McNeely, 1988; Repetto, 1988; Repetto and Gillis, 1988).

1. Knowledge gaps refer to the lack of an accepted scientific understanding about which variables are the primary causes of deforestation and biodiversity losses, and how these variables are linked to one another. Policies that suggest ways to improve the effects of deforestation are often based on a model or theory about why deforestation is accelerating. However, the current status of theoretical explanations of the causes of deforestation and biodiversity losses is in flux. No agreement exists within the scientific community concerning which of multiple contending models of deforestation and biodiversity loss are empirically valid.

2. Information gaps refer to a lack of reliable data about specific policy-relevant variables in a particular time and location. In other words, the data needed to test competing theories of deforestation and biodiversity losses are not generally available. Detailed data about forest conditions within a country that are important for policy making are also not available.

3. Assessment capability is the presence of permanent in-country centers with interdisciplinary staffs trained in rigorous forest mensuration techniques, participatory appraisal methods, institutional analysis, statistics, qualitative analysis, geographic information systems (GIS), and database management.

Alternative approaches to solving the problem

Within the U.S., the Committee on Environment and Natural Resources (CENR) of the National Science and Technology Council focused on the need for a better scientific foundation for future policy initiatives. CENR held a National Forum on Environment and Natural Resource R&D at the National Academy of Sciences in late March of 1994 in Washington, D.C. The Forum brought together representatives from industry, academia, nongovernmental organizations, Congress, and state and local governments to articulate their views on the strategy and priorities for issues related to environmental change. The Forum reached several conclusions about critical research needs that are relevant to the design of the IFRI research program. These include:

- An improved understanding of the environmental issues requires a long-term commitment to a balanced research program of systematic observations (monitoring), data and information systems, process studies, and predictions (CENR, 1994: 5).
- The areas most in need of augmentation are:
  1. the scientific basis for integrated ecosystem management;
  2. the socioeconomic dimensions of environmental change;
  3. science policy tools;
  4. observations, and information and data management; and
  5. environmental technologies (ibid.).

When focusing on the socioeconomic dimensions of environmental change, the Forum identified specific research that needed substantial augmentation and emphasis. These included efforts to:

- understand the societal drivers of environmental changes, including the analyses of the environmental impacts of various patterns and growth of population, economic growth, and international trade;
- promote policy analysis, including the design, comparison, and *ex post* evaluation of the effectiveness of policy alternatives to prevent, ameliorate, or manage environmental problems;
- promote the analysis of environmental goals, encompassing the concepts of distributive justice, procedural fairness, community participation, and economic well-being; and
- promote the analysis of the barriers to the diffusion of environmentally beneficial technologies (CENR, 1994: 6).

These critical research needs are challenging and require diverse approaches. One approach is that of global monitoring, relying primarily on national inventories and satellite imagery. Major progress to implement this approach has been taken by FAO (1993). A second approach is to link permanent forestry and agro-forestry Research Stations to foster more rapid exchange of scientific findings about how ecological systems are affected by (and affect) climate changes, increased pollution levels, and other environmental threats. Efforts of the U.S. National Science Foundation (NSF) to create such linkages have been successfully initiated.

A third approach—the one taken by the IFRI research program—complements the first two approaches and generates policy-relevant information not available from other strategies. The IFRI program provides an interdisciplinary set of variables about forest management and use that are assessed near the forest in relationship to the local communities utilizing and governing the forest. The effects of district, national, and international policies as they impact on a local setting can be assessed through this effort. The results of IFRI studies provide in-country information for policymakers at the local, district, regional, and national levels. This information will be collected by researchers who are deeply familiar with the local settings rather than collected from secondary sources that are compiled by international organizations or by national agencies drawing on various sources of externally compiled information. The IFRI research program relies on the building of a permanent international network of CRCs. Each CRC will:

- design a long-term monitoring plan to include a sample of forests located in different ecological zones, managed by diverse institutional arrangements, and located near centers of intense population growth as well as in more remote regions;

- conduct rigorous evaluations of projects undertaken to reduce deforestation, increase local participation, encourage eco-tourism, change forest tenure policies, implement new taxes or incentives, or in some way attempt to improve the incentives of officials and citizens to enhance and sustain forest resources and biodiversity;
- provide useful and rapid feedback to officials and citizens about conditions and processes in particular forests of relevance to them;
- archive data about environmental and institutional variables in a carefully designed database to be used within each country and to be shared among the participating research centers;
- conduct analyses of those policies and institutional arrangements that perform best in particular political-economic and ecological settings; and
- prepare materials of relevance for in-service training as well as for educational curricula.

Goals/outcomes: Addressing knowledge and information gaps and building assessment capacities

The goals of the IFRI program are to (1) address the issue of knowledge gaps by seeking ways to enhance interdisciplinary knowledge, (2) to address information gaps by providing a means to ground-truth aerial data and spatially link forest use to deforestation and reforestation, and (3) to address the need for greater assessment capabilities by building capacity to rigorously collect, store, analyze, and disseminate data in participating countries.

Goal: Addressing knowledge gaps

Any system of interaction involving a relatively large number of variables that relate to one another overtime with complex feedback loops is immensely more difficult to understand and control than simple systems tackled in more mechanistic areas, such as in classical physics. Human uses of forest resources involve a large number of potentially relevant variables that operate over time with complex feedback loops. Effective policy interventions are elusive until an empirically warrantable consensus is attained about the set of important variables that impinge on deforestation and biodiversity losses.

Recent attempts to understand processes leading to general environmental harms involve multivariable models. Paul and Anne Ehrlich (1991: 7), for example, propose a three-variable causal model:

$I = P \times A \times T$, where,

I = impact on the environment,
P = population size,
A = affluence (as measured by levels of consumption), and
T = technologies employed.

An alternative model developed by Grant (1994) for UNICEF to capture processes occurring primarily in developing countries is the PPE spiral where poverty and population pressures are viewed as reinforcing one another and jointly impinging on environmental conditions while all three factors—population, poverty, and environment—affect and are affected by political instability.

The extent of the knowledge gap becomes apparent upon careful examination of these two recent and respected models. They disagree on the size of the relationship between poverty on environmental variables.[12] The Ehrlichs include population *size* in their model, which is a state variable operationalized by either population density or the total number of people. The UNICEF model identifies population *growth* rather than current size. Technology appears in the Ehrlich model but not in the UNICEF model. Political instability appears in the UNICEF model but not in the Ehrlich model. The logical places to intervene are different depending on which model best describes the world. If one accepts the Ehrlichs' view, one should focus attention on the most affluent countries ignoring political instability. Accepting the UNICEF view, one would focus on the poorest countries and stress the impact of political instability.

The effect of opening a region to increased market pressures is also a matter of debate in the literature. Many scholars presume that integrating local resource systems into larger markets by building roads and market centers increases the temptation that local users face to overharvest (see, for example, Agrawal, 1994). On the other hand, William Ascher (1995) argues that providing the poor in remote regions with better access to income-earning activities reduces their need to overuse forest resources and encourages a longer time horizon in making decisions about the use of local resources (see also Fox, 1993).

The knowledge gap is illuminated further by an important study by Robert T. Deacon (1994) on "Deforestation and the Rule of Law in a Cross-Section of Countries."[13] Using FAO estimates of forest cover in 1980 and 1985 to measure the proportionate rate of deforestation between 1980 and 1985, Deacon first examines the impact of population growth. He finds, in support of the UNICEF model, that a "one

[12] *This may be due to the fact that UNICEF focuses primarily on the developing world, but then is the Ehrlich model limited primarily to the industrialized world?*

percent increase in population during 1975-1980 is associated with a proportionate forest cover reduction of 0.24 - 0.28 percent during 1980-85" (Deacon, 1994: 8). Supportive of the Ehrlich model, Deacon also finds that a "given rate of population growth is associated with a higher deforestation rate if it occurs in a high income country than in a low income country" (ibid.). While Deacon finds significant relationships, population change accounts for only a small proportion of the variance of deforestation (R^2 between .08 and .14).

The primary reason that Deacon undertakes this analysis, however, is to examine the impact of unstable or weakly enforced legal systems on deforestation. The decision to consume forest resources rapidly or to conserve them so as to yield a perpetual stream of future returns is an investment decision. Deacon argues that investments will only be made when those who make a sacrifice not to harvest immediately are assured they will receive the future benefits of their actions. "When legal and political institutions are volatile or predatory, the assurance is lowered and the incentive to invest is diminished" (ibid.: 3). Consequently, Deacon analyzes variables that reflect political instability and the presence of centralized national governments. These variables are positively associated with deforestation, and the proportion of the variance explained rises (R^2 between .19 and .21). Political and institutional variables account for as much or more variance in deforestation as population density. In the 120 countries included in his analysis, the size of the association between population growth and deforestation is reduced when political and institutional variables are included. The association falls substantially in low- and middle-income countries.[14] Deacon's analysis is pathbreaking because it is a rare effort to undertake a systematic analysis of the relative role of population density and institutional variables. He demonstrates that both have an impact on rates of deforestation. What his analysis also shows, however, is that factors affecting 80 percent of the variance in deforestation at a national level are not accounted for. This is a substantial knowledge gap.

While knowledge gaps about relationships at a national level remain immense, greater progress has been achieved in gaining a shared and empirically validated understanding of relationships at a more micro or sub-national level. In the mid-1980s, the National Academy of Sciences (NAS) established a Panel on Common Property Resources. Since then, many theoretical and empirical studies of diverse institutional arrangements for governing and managing small- to medium-sized

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[13] *Deacon did not set out to test either of the models proposed by the Ehrlichs or by UNICEF and made no reference to either of them. Deacon (1994: 2) stresses that the "causes of deforestation are not well understood" and that the causes posited by some analysts are absent in the discussions of others. Deacon's own view is that the insecurity of property rights is a major contributing factor to deforestation.*

[14] *In low- and middle-income countries, a 1 percent increase in population during 1975-1980 is associated with a proportionate forest cover reduction of 0.07 - 0.13 percent during 1980-85.*

natural resources have enabled scientists to achieve a growing consensus.[15] Scholars from diverse disciplines now tend to agree that the users of small- to medium-sized natural resources are potentially capable of self-organizing to manage these resources effectively, whether jointly with national governments or with considerable autonomy. Researchers have even identified localities within countries where local users have organized themselves effectively enough that they have improved forest conditions when faced with increasing population density.[16]

There are several reasons why local users may more effectively manage resources than national agencies. One reason is the immense diversity of local environmental conditions that exist within most countries. The variation in rainfall, soil types, elevation, scale of resource systems, and plant and animal ecologies is large, even in small countries. Some resources are located near to urban populations or a major highway system and others are remote. Given environmental variety, rule systems that effectively regulate access, use, and the allocation of benefits and costs in one setting, are not likely to work well in radically different environmental conditions. Efforts to pass national legislation establishing a uniform set of rules for an entire country are likely to fail in many of the locations most at risk. Users managing their resources locally may be a more effective way of dealing with immense diversity from site to site.

A second reason for the potential advantage of local organization in coping with problems of deforestation and biodiversity losses is that the benefits local users may obtain from careful husbanding of their resources are potentially greater when future flows of benefits are appropriately taken into account. At the same time, the costs of monitoring and sanctioning rule infractions at a local level are relatively low. These advantages occur, however, only when local users have sufficient assurance that they will actually receive the long-term benefits of their own investments.

While there is agreement that the potential for effective organization at a local level to manage some of the smaller- to medium-sized forests exists in all countries, local participants do not uniformly expend the effort needed to organize and manage local forests, however, even when given formal authority. Some potential organizations never form at all. Some do not survive more than a few months. Others organize but are not successful. Others are dominated by local elite who divert com-

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[15] Among the books that have been written since the NAS report that provide a foundation for this growing consensus are: McCay and Acheson, 1987; Fortmann and Bruce, 1988; Wade, 1994; Berkes, 1989; Pinkerton, 1989; Sengupta, 1991; V. Ostrom, Feeny, and Picht, 1993; Netting, 1993; E. Ostrom, 1990, 1992; E. Ostrom, Gardner, and Walker, 1994; Blomquist, 1992; Tang, 1991; and Thomson, 1992.

[16] These include the work of Fairhead and Leach (1992) in Guinée; Agrawal (1994) in India; Tiffen, Mortimore, and Gichuki (1994) in Kenya; Fox (1993) in Nepal; and Meihe (1990) in Senegal.

munal resources to achieve their own goals at the expense of others (Arora, 1994). In some cases, the natural forest must be almost completely gone before local remedial actions are taken. These actions may be too late. Still others do not possess adequate scientific knowledge to complement their own indigenous knowledge. Making investment decisions related to assets that mature over a long time horizon (25 to 75 years for many tree species) is a sophisticated task whether it is undertaken by barely literate farmers or Wall Street investors. In highly volatile worlds, some organize themselves more effectively and make better decisions than others.

Thus, the romantic view that anything local is better than anything organized at a national or global scale is not a useful foundation for a long-term effort to improve understanding of what factors enhance or detract from the capabilities of any institutional arrangement to govern and manage forest resources wisely. Any organization or group faces a puzzling set of problems when it tries to govern and manage complex multispecies (including Homo sapiens), multiproduct resource systems whose benefit streams mature at varying rates. Any organization or group will face a variety of environmental challenges stemming from too much or too little rainfall to drastic changes in factor prices, population density, or pollution levels. Consequently, essential knowledge can be gained from a carefully designed, systematic study of how many different types of institutional arrangements, including nascent groups, indigenous communal organizations, formal local governments, NGOs, specialized forest and park agencies, and national ministries, cope with diverse types of forest resources. Much is to be learned from both successes and failures. And, since we intend to use multiple performance measures, we expect to find some forest governance and management systems that are evaluated positively in regard to some evaluative criteria (such as the maintenance of forest density and species richness), but not necessarily in regard to others (such as gender representation, financial accountability, adaptability over time, or transparency of decision-making processes).

Outcome: Enhancing interdisciplinary knowledge. Prior theoretical and empirical studies provide an initial set of hypotheses about general factors that we expect to find associated with the more successful forest governance and management systems (see E. Ostrom, 1990; McKean, 1992; Moorehead, 1994). Thus, the IFRI research program begins with an initial set of working hypotheses that will be revised, added to, and refined over time.

Our initial working hypotheses are that more effective organization to cope with the long-term sustainable management of forest resources will occur where:

- local forest users participate in and have continuing authority to design the institutions that govern the use of a forest system;

- the individuals **most** affected by the rules that govern the day-to-day use of a forest system are included in the group that can modify these rules;
- the institutions that govern a forest system minimize opportunities for free riding, rent seeking, asymmetric information, and corruption through effective procedures for monitoring the behavior of forest users and officials[17];
- forest users who violate rules governing the day-to-day uses of a forest system are likely to receive graduated sanctions from other users, from officials accountable to these users, or both;
- rapid access is available to low-cost arenas to resolve conflict between users or between users and their officials;
- monitoring, sanctioning, conflict resolution, and governance activities are organized in multiple layers of nested enterprises; and
- the institutions that govern a forest system have been stable for a long period and are known and understood by forest users.[18]

The variables in these hypotheses are all operationalized using multiple indicators in the IFRI research instruments. Further, we have included other variables noted in the literature as being of importance in explaining processes of deforestation and biodiversity loss. Additional variables are included in the design of this study based on the Institutional Analysis and Development framework,[19] which has served as the theoretical foundation for many of the successful prior studies of the governance and management of natural resource systems undertaken by colleagues at Indiana University.

In the design of this study, we have also been concerned with how national and regional governments can enhance or detract from the capabilities of local entities by the kind of information they provide, by the assurance that they extend to ensure autonomy over the long run, by the provision of low-cost conflict resolution mechanisms, and by policies that allow localities to develop and keep financial resources that can be used to make local improvements. Detailed information about why some national policies tend to encourage successful self-organization and others

[17] Free-riding behavior occurs when individuals do not contribute to the provision and/or production of a joint benefit in the hopes that others will bear the cost of participating and that the free-riders will receive the benefits without paying the costs. Rent-seeking occurs when individuals obtain entitlements that enable them to receive returns that exceed the returns they would receive in an open, competitive environment. Asymmetric information occurs when some individuals obtain information of strategic value that is not available to others. Corruption occurs when individuals in official positions receive personal side-payments in return for the exercise of their discretion.
[18] These hypotheses are obviously stated in a very general manner. We are presently developing a working paper that specifies how more specific versions of these hypotheses could eventually be analyzed using the IFRI database.
[19] See Kiser and Ostrom, 1982; Oakerson, 1992; E. Ostrom, 1986; E. Ostrom, Gardner, and Walker, 1994.

discourage will be provided. These results will help to reduce knowledge gaps about policy impacts and thus facilitate the development of more effective policies.

The IFRI research program is designed to examine relationships among the physical, biological, and cultural worlds in a particular location and the *de facto* rules that are used locally to determine access to and use of a forest. During data collection, researchers will use ten research instruments. Examination of the physical world includes examination of the structure of forests and the species within. There are two research instruments that include rigorous forest mensuration methods in order to generate reliable and unbiased estimates of forest density, species diversity, and consumptive disturbances. Examination of cultural worlds includes gaining knowledge about patterns of socioeconomic and cultural homogeneity, number of individuals and groups involved, and diverse world views. Research conducted using a uniform set of variables using the best methods available for gaining reliable estimates of qualitative and quantitative data will enable scholars to analyze how different institutions work in the context of a large number of ecological, cultural, and political-economic settings. Diverse models of which variables and how they interact to affect behavior and outcomes will be posed, tested, and modified so that policies based on revised and tested models will have a higher probability of being successful than past efforts to reduce deforestation and stop biodiversity losses.

Goal: Addressing information gaps

Important steps have been taken in the last decade to increase the rigor and quantity of information known about forest cover and rates of deforestation and biodiversity losses in different parts of the world. In 1993, for example, the most "authoritative global tropical deforestation survey to be produced in more than a decade" (Aldhous, 1993: 1,390) was released by the United Nations Food and Agriculture Organization (FAO, 1993). This FAO report attempts to document the extent of deforestation in tropical countries in an accurate fashion but repeatedly stresses the problems that the project staff faced in obtaining reliable information for the task. After examining the current state of information about forest conditions in tropical countries, the project found that:

- There is considerable variation among regions with respect to completeness and quality of the information.
- There is considerable variation in the timeliness of the information. The data is about ten years old, on average, which could be a potential source of bias in the assessment of change.
- Only a few countries have reliable estimates of actual plantations, harvests, and utilization although such estimates are essential for national forestry planning and policy making.

- No country has carried out a national forest inventory containing information that can be used to generate reliable estimates of the total woody biomass volume and change.
- It is unlikely that the state and change information on forest cover and biomass could be made available on a statistically reliable basis at the regional or global level within the next ten or twenty years unless a concerted effort is made to enhance the country capacity in forest inventory and monitoring (FAO, 1993: 5-6).

The report concludes its findings concerning information gaps by noting that "forest resource assessments are among the most neglected aspects of forest resource management, conservation and development in the tropics" (ibid.: 6).

Outcome: Providing key ground-truthed information. The IFRI research program will immediately provide key information about variations in forest conditions and the incentives and behavior of forest users within countries participating in the IFRI network. This information is essential for policy analysis and to test theories addressing knowledge gaps. Focusing on a sample of forests located in diverse ecological regions and governed by different institutional arrangements greatly reduces the cost of monitoring as contrasted to national forest inventories. Further, it provides information about the variation of results achieved by different kinds of institutional arrangements.

Both quantitative and qualitative data will be collected about institutional arrangements, the incentives of different participants, their activities, and careful forest mensuration techniques will be used to assess consequences in terms of density, species diversity, and species distribution. The general type of information to be collected at each site is listed in Table A1. This information will immediately be made available to forest users and government officials, and used in regularized policy reports written by analysts who have a long-term stake in the success of the policies adopted. The results of projects adopted in one location can be compared with the results of other types of institutional arrangements in similar ecological zones within the same macro-political regime. The data will also be archived in an IFRI designed, relational database so that changes in institutions, policies, activities, and outcomes can be monitored over time and across regions within one or more than one country. Data will be collected, owned, assessed, stored, and analyzed by each countries' researchers. The IFRI research program fosters in-country development of information rather than sole reliance on the purchase of secondary data from international organizations. The program also encourages the development of "state-of-the-art" research conducted by researchers who have permanent roots in a country rather than coming in from the outside.

Table A1: Data collection forms and information collected

IFRI Form	Information Collected
Site Overview Form	site overview map, local wage rated, local units of measurement, exchange rates, recent policy changes, interview information
Forest Form	size, ownership, internal differentiation, products harvested, uses of products, master species list, changes in forest area, appraisal of forest condition
Forest Plot Form	tree, shrub, and sapling size, density, and species type within 1, 3, and 10 meter circles for a random sample of plots in each forest, and general indications regarding forest condition
Settlement Form	socio-demographic information, relation to markets and administrative centers, geographic information about the settlement
User Group Form	size, socioeconomic status, attributes of specific forest user groups
Forest-User Group Relationship Form	products harvested by user groups from specific forests and their uses
Forest Product Form	details on three most important forest products (as defined by the user group), temporal harvesting patterns, alternative sources and substitutes, harvesting tools and techniques, and harvesting rules
Forest Association Form	institutional information about forest association (if one exists at the site), including association's activities, rules structure, membership, record keeping
Nonharvesting Organization Form	information about organizations that make rules regarding a forest(s) but do not use the forest itself, including structure, personnel, resource mobilization, and record keeping
Organizational Inventory and Interorganizational Arrangements Form	information about all organizations (harvesting or not) that relate to a forest, including harvest and governance activities

Goal: Building capacity for assessment

The third major goal of the IFRI research program is to build in-country capacities to conduct forest and institutional assessments on a continuing basis. As the FAO (1993) *Forest Resources Assessment* report cited above indicates, developing sustained efforts to gain an accurate picture of forest conditions or to build a valid understanding of what factors affect forest conditions is impossible *without building in-country assessment capabilities*. There are extraordinary researchers in each country with substantial capabilities that could be utilized in a sustained assessment program. These scholars may be located in different research institutions and separated by disciplinary barriers. Recent developments in the use of computers may not have been made available. For whatever reason, few countries have brought together interdisciplinary teams with extensive training in biology, environmental science, social sciences, and the use of computers to conduct regular assessments that can be used to fill information gaps and gain more valid understanding of the variables that affect rates of deforestation and loss of biodiversity.

The IFRI research program will work with a growing group of in-country research centers who obtain funding from donors and their own institutions to build their capabilities to become a permanent assessment center.

Outcome: Legacy of long-term assessment capabilities. In addition to addressing the problems of reducing knowledge and information gaps to enhance future forestry policy making, the IFRI research program will leave a legacy in each participating country of a core research team that is well-trained in social and biological research methods and the computers to do analysis and manage complex forestry data sets.

Operational methods of IFRI research program

As a research program, we envision a process of policy-relevant theoretical development, data collection, analysis, policy reporting, and training that is ongoing for the next decade or more. The overarching plan for the IFRI program is that future research goals and objectives will be addressed by a network of CRCs and individual scholars who design and conduct studies within different countries in collaboration with colleagues at the Workshop in Political Theory and Policy Analysis and the Center for the Study of Institutions, Population, and Environmental Change (CIPEC). An IFRI CRC could be a research group associated with a university, a private association, a government research laboratory, or a consortium of individuals and agencies that have agreed to work together to collect, analyze, and archive IFRI data in a particular country or specific region of the world. Individual researchers who are working at a university or research institution completing their doctoral research or working independently may also be associated with IFRI.

The IFRI program includes a training model for each CRC that is intensive in the first two years. Each CRC will send key research personnel for a one-semester training program conducted by staff at Indiana University. This will be followed up with an in-country training program of a month's duration where the initial core set of researchers from a particular country or region are provided classroom and experiential training opportunities by Indiana University staff and by the local researchers who have just completed the semester in Bloomington. Pilot studies will be conducted soon after this initial training program has been completed. During the pilot studies, the Bloomington staff will be prepared to respond to methodological queries as in-country researchers discover the many complex and unexpected relationships using the methods they have just learned. As local staff become experts in the field administration, analysis, and archival of the data, further training will be taken over by those heading each of the CRCs. We also see a role for staff from one CRC visiting and working with staff from a second CRC so that the reliability of field methods and interpretations is enhanced.

Criteria for selecting CRCs will be based primarily on level of interest in solving forest resource problems from the bottom up, previous work on forest issues, and capacity to use the database system in an environment that enables communication between nongovernmental policymakers, forest users, governmental policymakers, scholars, and grant-writing capabilities. Demonstrated commitment to continuing, long-term research efforts will also be a criteria for CRC selection.

We envision that each CRC will go through several phases of relating to the Workshop/CIPEC and to other CRCs in the IFRI network. During the first phase—normally about a year in duration—one or two researchers, who will take a major role in the development of the CRC, would spend at least one semester at Indiana University. They will participate in a general course of study that includes both the underlying theoretical foundations for the IFRI research program and a specific training program on forest mensuration, PRA methods, detailed review of all IFRI research instruments, and joint fieldwork in a site near to Indiana University.

Ideally during the summer following the above training program, researchers from the CRC and Indiana University will jointly train a larger group of researchers in data collection and entry methods and jointly conduct one to four pilot studies together. By working side-by-side in the conduct of the initial pilot studies, many of the problems that have faced earlier efforts to undertake multinational research efforts should be reduced. A key problem facing all such studies is how to establish and keep consistent data collection methods so that the data placed in the same fields in the database are actually comparable. No amount of classroom instruction can cope effectively with this problem. Working side-by-side in the initial studies in each country is one method of substantially increasing the reliability and validity of the data collection efforts. Further, working out data entry procedures and queries is equally important in developing a database that is robust and can be used over many years and by many participants.

After completing its first round of pilot studies, a new CRC will participate in a meeting of all CRCs. The first such meeting took place at Oxford University in mid-December of 1994, the second at Berkeley in June of 1996, and the third at CIFOR in November of 1997.

During initial training and pilot studies, the person taking primary responsibility for the development of a CRC in a particular country or region will begin work, in consultation with his or her own colleagues and with colleagues at Indiana University, on a research design for a continuing assessment program using the IFRI research instruments. Each monitoring plan will identify major knowledge and information gaps that will be addressed if the program outlined in it were undertaken. Where there are specific questions of importance in a particular country or region not covered by the IFRI research instruments, these will be supplemented with new instruments designed by the CRC and shared with other members of the Network. The monitoring plan will be circulated among members of the IFRI network, to public officials and NGOs in the host country, and eventually to potential donors for funding. Once funding is received and the appropriate staff has been hired, the CRC will begin its own research program. Researchers from each CRC will visit other CRCs and undertake joint fieldwork with the researchers from other CRCs. This is another way that consistent data collection and interpretation can be undertaken in a multinational study.

Dissemination of results

The results of the IFRI research program will be disseminated in multiple ways that include:

- immediate feedback of a site report to forest users and government officials interested in each site. The site report will contain a list of all plant species located in the forest(s) in the site, their relative importance and density, a history of each settlement, and an overview of the activities of user groups.
- policy analysis reports issued by each CRC annually, summarizing the findings from the sample of forests and forest institutions included in that year's study. In the early years, these will be based on cross-sectional information. In the later years, these will contain analyses of developments over time. These reports will be widely circulated to policymakers, forest users, and scholars within each country and to all of the other IFRI CRCs.
- special project reports comparing the activities and results obtained by a particular government, donor, or NGO-sponsored project with other institutional arrangements existing in similar ecological

zones. These reports will also be widely circulated to policymakers, forest users, and scholars within each country and to all of the other IFRI CRCs.

- M.A. and Ph.D. theses completed by students who work at those CRCs that are located within universities or other in-country (or U.S.) universities. These studies will address some of the more difficult knowledge gaps that cannot be addressed in the initial policy reports.
- methodological reports written by CRC and Indiana University scholars addressing some of the difficult measurement problems involved in the conduct of a multicountry, over-time study of institutional, behavioral, as well as forest condition variables. These will be circulated to interested researchers throughout the world.
- scholarly publications submitted by CRC and Indiana University scholars to academic journals and university presses so that the findings become part of the generally available knowledge base for social scientists, foresters, biologists, and public policy scholars.
- synopses of policy reports and more analytical reports that will be made available through the Internet to a wide diversity of interested colleagues who are connected electronically.
- training programs for public officials held at CRCs once the in-country database is sufficient to provide better evidence for in-country forest planning.
- curricular materials prepared for introduction into undergraduate and graduate instruction in relevant disciplinary courses.

Initial reaction of forest users and government officials to IFRI research reports has been enthusiastic. The volume, of which this appendix is a part, is also an effort to make the results known to public officials, forest users, and scholars throughout the world. Members of the IFRI teams involved will be glad to hear from readers and learn what has, or has not, been useful in our initial series of studies.

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