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Self-Governance and Forest Resources

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Preface

Under the twin pressures of shrinking state budgets and popular demands for a greater voice in resource management decision making, there has been a virtual explosion of interest in forests managed by communities among researchers, policy makers, development practitioners and community activists in recent years. In keeping with these trends, one of CIFOR's focus areas for research is forest managed by communities. Under the project title 'Local People, Devolution and Adaptive Co-Management', this research attempts to define and explain the conditions that allow communities to manage forests sustainably and in a way that supports local livelihoods. It is increasingly clear that an important condition for this kind of community-based management is a vibrant and viable set of community-based forest management institutions.

Community-based forest management institutions, or the sets of rules and norms that guide decisions about resource management by community members, have received increasing attention from governments, donors and NGOs over the past decade or so. These organisations, seeing themselves as stakeholders in community-managed forests, want to understand how community-based institutions work and how they can be supported, reoriented or recreated to advance particular environment and development goals (World Bank 1992; Western and Wright 1995; FAO 1997). At the same time, communities have sought recognition for their existing institutions and help in adapting to changing social and environmental circumstances (Jodha 1986; Okoth-Ogendo 1987; Sarin 1993; Rocheleau and Ross 1995; Bebbington *et al.* 1997; Leach *et al.* 1997).

Researchers from diverse disciplines have responded to these calls for greater understanding of community-based institutions (Fortmann and Bruce 1988; North 1990; Peters 1994; Peluso 1996). There is now a considerable body of work describing the forms these institutions take, analysing how they function and with what impacts on different people and environments, and placing them in broader environment and development contexts. The research analysing local forest management institutions has been very rich (Fisher 1988; Poffenberger 1990; Shepherd 1992; Arnold 1997; Malla 1997; Richards 1997).

It is not clear, however, whether this research is helping us to advance or create the necessary conditions for community-based forest management practices that are both sustainable and supportive of local livelihoods. CIFOR and the International Forestry Resources and Institutions Program (IFRI) organised a workshop in

November 1997 to address this concern. The workshop, entitled 'Local Institutions for Forest Management: How Can Research Make a Difference', had several goals: to review some of the current research on community-based institutions; to assess the research impact on actual management practice; and to outline new directions for research that can support/improve community-based forest management. To achieve the workshop's goals, participants began by examining the theoretical foundations of our research and tried to decide where the strengths and weaknesses in those foundations lay.

One of the most theoretically coherent and influential bodies of research on community-based institutions has been developed under the direction of Dr Elinor Ostrom of Indiana University. Focussing on the kinds of institutions that support collective action at the community level, Dr Ostrom has developed a set of conceptual tools that can help us predict when collective action institutions will be effective. These tools are organised as: 1) a list of attributes of both the resource in question and of the users of that resource that make it less costly for local groups to establish 'robust' collective action institutions; and 2) a set of design principles that characterise such 'robust' institutions. These attributes and design principles are not meant as a checklist for determining – independent of a specific research context – whether or not local institutions are robust. They have served, however, as a guide to research that seeks to explain the relative success or failure of community-based institutions in sustaining local environments and livelihoods.

Dr Ostrom contributed a paper entitled 'Self-Governance and Forest Resources' to the IFRI/CIFOR workshop in which she outlined her theory on community-based institutions and IFRI's ongoing efforts to test empirically the theory's relevance for forest management. Workshop participants discussed at length how these concepts, developed primarily from work on common pool resources other than forests, might be applied to the study of forest management. They also discussed how Dr Ostrom's theory could be useful in a practical sense to policy makers, development practitioners and community activists.

Some workshop participants suggested that more research might be needed to adapt Dr Ostrom's concepts to the complexity of forest management. Forests can generate a large number of different products and services, forest user interests are often diverse and competing, multiple rights to forests may overlap and contradict one another, and there can be considerable

uncertainty about the environmental impact of specific forest management practices. Each of these issues greatly complicates the task of local forest managers, and of the researchers evaluating the likely success of forest management institutions. Of course, in the most difficult cases, neither the development of a common property regime nor a high degree of local self-governance may be possible or even desirable, as Dr Ostrom has pointed out elsewhere (McKean and Ostrom 1995). What is not yet clear, however, is whether the concepts are sufficiently developed for forests to inform us with some certainty when specific local institutions *are* viable and desirable.

Other participants commented that it is very difficult to situate local institutions in their broader institutional context, particularly as the roles of the state and market actors in forest management are changing rapidly in many locations. Dr Ostrom has gone some way in addressing this challenge in her writings on co-production (E. Ostrom 1996), but suggests that more research is needed in this area also. Finally, several participants mentioned that the material and symbolic values of forests in local political conflicts often have a profound impact on forest management. An assessment of the robustness of local institutions may have to take better account of such local politics.

Most workshop participants agreed, however, that Dr Ostrom's concepts are already important tools for analysing local forest management institutions. Many participants also suggested that her work has immediate

practical value. Representatives of community-based organisations, for example, commented that the concepts would help them make a cogent case to governments and donors that existing community-based institutions should be recognised and legitimated. Government and donor representatives found clear guidelines in Dr Ostrom's work for recognising where local institutions are likely to be effective and how 'outsiders' might go about encouraging the development of robust community-based institutions. In both analytical and practical terms, further elaboration of the theory appears very promising for those interested in understanding and supporting community-based forest.

We at CIFOR are very pleased to be able to publish Dr Ostrom's paper 'Self-Governance and Forest Resources'. Her work has already inspired considerable research on community-based institutions, and continues to be at the forefront of theoretical debates on such institutions (IASCP 1998). This is an important theoretical piece dedicated explicitly to forest management. We believe it is required reading for all those who have an interest in community-based forest management. We hope those who read it will engage it in the same spirit as did our workshop participants – identifying how we can build on and adapt Dr Ostrom's theory to better understand and support community-based management that sustains both environments and people.

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SELF-GOVERNANCE AND FOREST RESOURCES¹

Elinor Ostrom²

Executive Summary

Forest resources share attributes with many other resource systems that make difficult their governance and management in a sustainable, efficient and equitable manner. Destruction or degradation of forest resources is most likely to occur in open-access forests where those involved, or external authorities, have not established effective governance. Conventional theories applied to forest resources presumed that forest users themselves were incapable of organising to overcome the temptations to overharvest. Extensive empirical research, however, has challenged this theory and illustrated the many ways that forest users themselves have devised rules that regulate harvesting patterns so as to ensure the sustainability of forest resources over time.

There is now a large body of literature analysing common-pool resources such as many fisheries, irrigation systems and rangelands. A growing consensus exists in this literature concerning the attributes of common-pool resources and of resource users that enhance the probability that self-organisation will occur. Many of these attributes seem also to help predict when forest users will self-organise. Forest users are more likely to devise their own rules when they use a forest that is starting to deteriorate but has not substantially disappeared, when some forest products provide early warning concerning forest conditions, when forest products are predictably available, and when the forest is sufficiently small that users can develop accurate knowledge of conditions. Self-organisation is more likely to occur when forest resources are highly salient to users, when users have a common understanding of the problems they face, when users have a low discount rate, when users trust one another, when users have autonomy to make some of their own rules, and when users have prior organisational experience. These attributes of forests and of the user community affect the benefits and costs of organising to protect and enhance forest resources. When users create organisations consistent with a set of design principles, they are likely to be able to sustain their own institutional arrangements over a long period of time.

This growing consensus about the attributes of users and resources has been applied in the design of policies intended to enhance the participation of local users in the governance and management of common-pool resources, including many forests. Supporting further research – especially studies of forests and their users over time – is an important foundation for even more effective public policies in the future.

INTRODUCTION

Forest resources share attributes with many other resource systems that make difficult their governance and management in a sustainable, efficient and equitable manner. While some 'forests' are small enough that fencing them or protecting their borders from intrusion is relatively easy, excluding beneficiaries from access and use of most forests is costly. The difficulty of exclusion creates the possibility that individuals who benefit from the use of a forest will not contribute to its long-term sustainability. For many uses of a forest, one person's harvesting subtracts products that are not available to others. Thus, many aspects of forests can be considered as common-pool resources. Common-pool resources are characterised by difficulty of exclusion and generate finite quantities of resource units so that one

person's use subtracts from the quantity of the resource available to others (E. Ostrom *et al.* 1994). The ecosystem services generated by forest resources – watershed protection, carbon sequestration, biodiversity enhancement, etc – may be considered as externalities or as public goods. Ecosystem services are, however, closely tied to the sustainability of the forest stock, and are thus threatened by the same set of incentives that tempt users of an unregulated forest resource into a race to use up the timber and destroy the forest itself.

¹ Paper presented at the conference on 'Local Institutions for Forest Management: How Can Research Make a Difference', Center for International Forestry Research (CIFOR), Bogor, Indonesia, November 19-21 1997.

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Destruction or degradation of forest resources is most likely to occur in open-access forests where those involved and/or external authorities have not established an effective governance regime to regulate the following:

- who is allowed to appropriate forest products;
- the timing, quantity, location and technology of appropriation;
- who is obligated to contribute labour or funds to provide or maintain the forest;
- how appropriation and obligation activities are to be monitored and enforced;
- how conflicts over appropriation and obligation activities are to be resolved; and
- how the rules affecting the above will be changed over time with changes in the extent and composition of the forest and the strategies of participants.

A self-governed forest resource is one where actors, who are major users of the forest, are involved over time in making and adapting rules within collective-choice arenas regarding the inclusion or exclusion of participants, appropriation strategies, obligations of participants, monitoring and sanctioning, and conflict resolution. Some extremely remote forests are governed entirely by users and not at all by external authorities. In most modern political economies, however, it is rare to find any resource system – including the treasuries of private for-profit corporations – that are governed *entirely* by participants without rules made by local, regional, national, and international authorities also affecting key decisions (V. Ostrom 1991, 1997). Thus, in a self-governed system, participants make many, but not all, rules that affect the sustainability of the resource system and its use.

THE CONVENTIONAL THEORY OF COMMON-POOL RESOURCES

Much of the literature on common-pool resources is derived from work on irrigation systems, fisheries and rangelands, but forests are also frequently studied as common-pool resources. Most theoretical studies by political economists have analysed simple common-pool resource systems using relatively similar assumptions (Feeny *et al.* 1996). In such systems, it is assumed that the resource generates a highly predictable, finite supply of one type of resource unit (hardwood timber, for example) in each relevant time period. Users are assumed to be homogeneous in terms of their assets, skills, discount rates and cultural views. They are also assumed to be short-term, profit-maximising actors who possess complete information. In this theory, *anyone* can enter the resource and appropriate resource units. Users gain property rights only to what they harvest, which they then sell in an open competitive market. The

open-access condition is a given. The users make no effort to change it. Users act independently and do not communicate or coordinate their activities in any way. The prediction from this theory is that overharvesting will result.

Until recently, textbooks in resource economics presented this conventional theory as the *only* theory needed for understanding common-pool resources (for a different approach, see Baland and Platteau 1996). With the growing use of game theory, use of a common-pool resources is frequently represented as a one-shot or finitely repeated, Prisoner's Dilemma game (Dawes 1973; Dasgupta and Heal 1979). These models formalise the problem differently, but do not change any of the basic theoretical assumptions about the finite and predictable supply of resource units, complete information, homogeneity of users, their maximisation of expected profits, and their lack of interaction with one another or capacity to change their institutions. Nor is the prediction changed.

The empirical validity of the theory was not effectively challenged until the mid-1980s since there were many dramatic examples of resources destroyed by users acting independently. The massive deforestation in tropical countries and the desertification of the Sahel confirmed the worst predictions to be derived from this theory for many scholars. Garrett Hardin's (1968) dramatic article in *Science* convinced many non-economists that this theory captured the essence of the problem facing users of most forests in the world. Since users are viewed as being trapped in these dilemmas, recommendations were repeatedly made that external authorities must impose a different set of institutions on such settings. Some recommend private property as the most efficient form of ownership (Demsetz 1967; Posner 1977; Simmons *et al.* 1996). Others recommend government ownership and control (Ophuls 1973). Implicitly, theorists assume that regulators will act in the public interest and understand how ecological systems work and how to change institutions so as to induce socially optimal behaviour (Feeny *et al.* 1996: 195).

The possibility that the users themselves would find ways to organise had not seriously been considered in much of the policy literature until the last decade. Organising so as to create rules that specify rights and duties of participants creates a public good for those involved. Anyone who is included in the community of users benefits from this public good, whether they contribute or not. Thus, getting 'out of the trap' is itself a second-level dilemma. Further, investing in monitoring and sanctioning activities in order to increase the likelihood that participants follow the agreements they have made,

also generates a public good. These investments, therefore, represent a third-level dilemma. Since much of the initial problem exists because the individuals are stuck in a setting where they generate negative externalities for each other, it is not consistent with the conventional theory that they solve a second- and third-level dilemma in order to address the first-level dilemma under analysis.

Until the work of the National Academy of Sciences' Panel on Common Property (National Research Council 1986), the conclusions derived from this basic theory were applied to all common-pool resources regardless of what kind of institutions local users developed. The growing evidence from many field studies of common-pool resources, however, called for a serious rethinking of the generalisability of the conventional theory (see Berkes 1986, 1989; Berkes *et al.* 1989; E. Ostrom 1990; Bromley *et al.* 1992; McCay and Acheson 1987; Agrawal forthcoming). Empirical studies have challenged the applicability of the conventional theory to forests by showing how forest users in many locations have organised themselves to vigorously protect and, in some cases, enhance local forests (Fortmann and Bruce 1988; Fox 1993; Fairhead and Leach 1996). Often, problems in forest management have emerged when local self-organisation has not been recognised by policy makers, and the autonomy of forest users to continue their own forest use practices has been threatened (Arnold and Campbell 1986; Gillis 1988; Arnold and Stewart 1991).

Loss of ownership combined with substantial increases in population, greater commercialisation of forest products and technological changes that made rapid deforestation possible, have increasingly threatened forests in all parts of the world (Jodha 1986; Poffenberger 1990; Messerschmidt 1993). Evidence has been mounting from a wide variety of sources, however, that local forest users are still capable of managing forest resources in many diverse locations (Ascher 1995; Becker *et al.* 1995; Agrawal and Yadama 1997; Shivakoti *et al.* 1997). Considerable interest has been rekindled in promoting various forms of community forestry institutions (Peluso and Poffenberger 1989; Alcorn 1990; Herring 1990; Gilmour and Fisher 1992; Shepherd 1992; Lynch and Talbott 1995; Ford Foundation 1998).

The International Forestry Resources and Institutions (IFRI) research programme is also conducting a series of studies on forests owned by governments, communally and privately. These studies are designed and implemented by a network of Collaborating Research Centers (CRCs) located in Bolivia, India,

Kenya, Madagascar, Mali, Nepal, Tanzania, Uganda and the United States (see Gibson *et al.* 1998; E. Ostrom 1998). As each of the CRCs is able to expand the number of research sites and to return to these sites on a regular basis, we hope to provide the kind of systematic evidence needed to ground theory developed from a broad range of common-pool resources in a strong empirical foundation specific to forests. Colleagues associated with the Center for the Study of Institutions, Population, and Environmental Change (CIPEC) at Indiana University are also intensively studying diverse forests in Brazil, Guatemala, Honduras and Mexico. Initial findings are highly congruent with the emerging theory described below (Agrawal 1998; Banana and Gombya-Ssembajjwe 1998; Becker and Gibson 1998; McKean 1998; Schweik 1998; Varughese 1998).

A GROWING CONSENSUS ON VARIABLES ENHANCING SELF-ORGANISATION

Evidence from field research on common-pool resources challenges the generalisability of the conventional theory. While the conventional theory is successful in predicting outcomes in settings where users are alienated from each other or cannot communicate effectively, it does not provide an explanation for settings where users are able to create and sustain agreements to avoid serious problems of overappropriation. Nor does it predict well when government ownership will perform appropriately or how privatisation will improve outcomes. A fully articulated, reformulated theory encompassing the conventional theory as a special case does not yet exist. On the other hand, scholars familiar with the results of field research substantially agree on a set of variables that enhance the likelihood of users organising themselves to avoid the social losses associated with open-access, common-pool resources (E. Ostrom 1990, 1992a, b; Schlager 1990; McKean 1992, 1998; Tang 1992; E. Ostrom *et al.* 1994; Wade 1994; Baland and Platteau 1996; Arnold 1998). Drawing heavily on Ostrom (1992b: 298-9) and Baland and Platteau (1996: 286-9), considerable consensus exists that the following attributes of common-pool resources and of users are conducive to an increased likelihood that self-governing associations will form. Though further empirical work is needed to test their relevance and explanatory power for self-organised forest management, these attributes do appear to have broad applicability.

Attributes of the Resource:

- R1. Feasible improvement: The resource is not at a point of deterioration such that it is useless to organise or so underutilised that little advantage results from organising.

- R2. Indicators: Reliable and valid information about the general condition of the resource is available at reasonable costs.
- R3. Predictability: The availability of resource units is relatively predictable.
- R4. Spatial extent: The resource is sufficiently small, given the transportation and communication technology in use, that users can develop accurate knowledge of external boundaries and internal microenvironments.

Attributes of the Users:

- A1. Saliency: Users are dependent on the resource for a major portion of their livelihood or other variables of importance to them.
- A2. Common understanding: Users have a shared image of the resource (attributes R1, 2, 3 and 4 above) and how their actions affect each other and the resource.
- A3. Discount rate: Users have a sufficiently low discount rate in relation to future benefits to be achieved from the resource.
- A4. Distribution of interests: Users with higher economic and political assets are similarly affected by a current pattern of use.
- A5. Trust: Users trust each other to keep promises and relate to one another with reciprocity.
- A6. Autonomy: Users are able to determine access and harvesting rules without external authorities countermanding them.
- A7. Prior organisational experience: Users have learned at least minimal skills of organisation through participation in other local associations or learning about ways that neighbouring groups have organised.

Many of these variables are in turn affected by the type of larger regime in which users are embedded. Larger regimes can facilitate local self-organisation by providing accurate information about natural resource systems, providing arenas in which participants can engage in discovery and conflict-resolution processes, and providing mechanisms to back up local monitoring and sanctioning efforts. The probability of participants adapting more effective rules in macroregimes that facilitate their efforts over time is higher than in regimes that ignore resource problems entirely or, at the other extreme, presume that all decisions about the governance and management of resources need to be made by central authorities.

The key to further theoretical integration is to understand how these attributes interact in complex ways to affect the basic benefit-cost calculations of a set of users utilising a resource (E. Ostrom 1990: Ch. 6). Each user i has to compare the expected net benefits of harvesting

from a resource continuing to use the old rules (BO) to the benefits he or she expects to achieve with a new set of rules (BN).³ Each user i must ask whether his or her incentive to change (D_i) is positive or negative.

$$D_i = BN_i - BO_i.$$

If D_i is negative for all users, no one has an incentive to change. If D_i is positive for some users, they then need to estimate three types of costs: C1 – the up-front costs of time and effort spent devising and agreeing upon new rules; C2 – the short-term costs of adopting new harvesting strategies; and C3 – the long-term costs of monitoring and maintaining a self-governed system over time (given the norms of the community in which they live). If the sum of these expected costs for each user exceeds the incentive to change, no user will invest the time and resources needed to create new institutions. Thus, if

$$D_i < (C1_i + C2_i + C3_i)$$

for all $i \in A$ (where A is the entire set of users), no change occurs.

In field settings, not everyone is likely to expect the same costs and benefits from a proposed change. Some may perceive positive benefits after all costs have been taken into account, while others perceive net losses. Consequently, the collective-choice rules used to change the day-to-day operational rules related to harvesting, planting, monitoring and other management activities affect whether an institutional change favoured by some and opposed by others will occur. For any collective-choice rule, such as unanimity, majority, ruling elite or one-person rule, there is at least one minimal coalition of users that must agree prior to the adoption of new rules. If there is an individual k in all minimal coalitions for whom

$$D_k \leq (C1_k + C2_k + C3_k),$$

no new rules will be adopted. And if for at least one minimal coalition

$$D_k > (C1_k + C2_k + C3_k),$$

for all members, it is feasible for a new set of rules to be adopted. If there are several such coalitions, the question of which coalition will form, and so which rules will result, is a theoretical issue beyond the scope of this discussion. This analysis is applicable to a situation where a group starts with an open-access set of rules and contemplates adopting its first set of rules limiting access. It is also relevant to the continuing consideration of changing rules over time.

³ These comparisons can be very difficult to make in practice. It is particularly difficult to estimate future benefits and costs to come from a change in rules since considerable uncertainty always exists concerning the strategies that participants will follow once rules are changed. But even though this is a difficult task, it is one undertaken frequently by users after a lot of time spent discussing the pros and cons of a change in rules.

Thus, the existing collective-choice arrangements in a location for making operational rules related to the entry and use of forests affects whether self-organisation will occur. Existing institutional arrangements also have a major effect on the distributional impacts of any rule changes that may occur. The rule used to modify institutional arrangements in field settings varies from reliance on the decisions made by one or a few leaders, to a formal reliance on majority or super-majority vote, to reliance on consensus or close to unanimity. If there are substantial differences in the perceived benefits and costs of users, it is possible that a minimal coalition will impose a new set of rules that strongly favours those in the winning coalition and imposes losses or lower benefits on those in the losing coalition (Thompson *et al.* 1988). If expected benefits from a change in institutional arrangements are not greater than expected costs for many users, however, the costs of enforcing a change in institutions will be much higher than when most participants expect to benefit from a change in rules over time. Where the enforcement costs are fully borne by the members of a minimal coalition, operational rules that benefit the other users lower the long-term costs of monitoring and sanctioning for a governing coalition. Where external authorities enforce the rules agreed upon by a coalition of users, the distribution of costs and benefits is more likely to benefit that coalition and may impose costs on the other users (see Walker *et al.* 1997).

The attributes of a resource (listed above) affect both the benefits and costs of institutional change. If resource units are relatively abundant (R1), there are few reasons for users to invest costly time and effort in organising. If the resource is already substantially destroyed, the high costs of organising may not generate substantial benefits. Thus, self-organisation is likely to occur only after users observe substantial scarcity. The danger here, however, is that exogenous shocks leading to a change in relative abundance of the resource units occur rapidly and users may not adapt quickly enough to the new circumstances (Libecap and Wiggins 1985).

The presence of frequently available, reliable indicators about the conditions of a resource (R2) improves the capacity of users to adapt relatively quickly to changes that could adversely affect their long-term benefit stream (Moxnes 1996). A resource flow that is highly predictable (R3) is much easier to understand and manage than one that is erratic. In the latter case, it is always difficult for users (or, for that matter, for scientists and government officials) to judge whether changes in the resource stock or flow are due to overharvesting or to random exogenous variables (see Feeny *et al.* 1996 for a discussion of these issues related to the collapse of the California sardine industry). Unpredictability of resource units in microsettings, such as private pastures,

may lead users to create a larger common-property unit to increase the predictability of resource availability somewhere in the larger unit (Netting 1972; Wilson and Thompson 1993). The spatial extent of a resource (R4) affects the costs of defining reasonable boundaries and then of monitoring them over time.

The attributes of the users themselves (listed above) also affect their expected benefits and costs. If users do not obtain a major part of their income from a resource (A1), the high costs of organising and maintaining a self-governing system may not be worth their effort. If users do not share a common understanding of how complex resource systems operate (A2), they will find it extremely difficult to agree on future joint strategies. Given the complexity of many forest resources – especially multispecies or multiproduct resources – understanding how these systems work may be counterintuitive even for those who make daily contact with the forest. In forests that are highly variable (R3), it may be particularly difficult to understand and to separate those outcomes stemming from exogenous factors and those resulting from the actions of users. Of course, this is also a problem facing officials as well as users. Users with many other options, who thus discount the importance of future income from a particular resource (A3), may prefer to ‘mine’ one forest without spending resources to regulate it. They simply move on to other forests once this one is destroyed, assuming there will always be still more forests available to them.

Users who possess more substantial economic and political assets may have similar interests to those with fewer assets (A4) or they may differ substantially on multiple attributes. When the more powerful have similar interests, they may greatly enhance the probability of successful organisation if they invest their resources in organising a group and devising rules to govern that group. Those with substantial economic and political assets are more likely to be a member of a winning coalition and thus have a greater impact on decisions about institutional changes. Mancur Olson (1965) long ago recognised the possibility of a privileged group whereby some were sufficiently affected to bear a disproportionate share of the costs of organising to provide public goods (such as the organisation of a collectivity). On the other hand, if those with more assets also have low discount rates (A3) related to a particular resource and lower salience (A1), they may simply be unwilling to expend inputs or may actually impede organisational efforts that might lead to them having to cut back on their productive activities.

Users who trust one another (A6) to keep agreements and use reciprocity in their relationships face lower expected costs for monitoring and sanctioning over time.

Users who lack trust at the beginning of a process of organising may be able to build this form of social capital (Coleman 1988; E. Ostrom 1992a) if they initially adopt small changes that most users follow before trying to make major institutional changes. Autonomy (A7) tends to lower the costs of organising. A group that has little autonomy may find that those who disagree with locally developed rules seek contacts with higher-level officials to undo the efforts of users to achieve regulation. With the legal autonomy to make their own rules, users face substantially lower costs in defending these rules against other authorities. Prior experience with other forms of local organisation (A7) greatly enhances the repertoire of rules and strategies known by local participants as potentially useful to achieve various forms of regulation. Further, users are more likely to agree upon rules whose operation they understand from prior experience, than upon rules that are introduced by external actors and are new to their experience. Given the complexity of many field settings, users face a difficult task in evaluating how diverse variables affect expected benefits and costs over a long time horizon. In many cases, it is just as difficult, if not more so, for scientists to make a valid and reliable estimate of total benefits and costs and their distribution.

The growing theoretical consensus does *not* lead to a conclusion that most users utilising common-pool resources will undertake self-governed regulation. Many settings exist where the theoretical expectation should be the opposite. Users will overuse the forest unless efforts are made to change one or more of the variables affecting perceived costs or benefits. Given the number of variables that affect these costs and benefits, many points of external intervention can enhance or reduce the probability of users' agreeing upon and following rules that generate higher social returns. But both social scientists and policy makers have a lot to learn about how these variables interact in field settings and even how to measure them so as to increase the empirical legitimacy of the growing theoretical consensus. Many aspects of the macroinstitutional structure surrounding a particular setting affect the perceived costs and benefits. Thus, external authorities can be effective in enhancing the likelihood and performance of self-governing institutions. Their actions can also seriously impede these developments as well. Further, when the activities of one set of users, A, have 'spillover effects' on others beyond A, external authorities can either facilitate processes that allow multiple groups to solve conflicts arising from negative spillovers or take a more active role in governing particular forests themselves.

Researchers and public officials need to recognise the multiple manifestations of these attributes in the field. Users may be highly dependent on a forest (A1), for example, because they are in a remote location and few

roads exist to enable them to leave. Alternatively, they may be located in a central location, but other opportunities are not open to them due to lack of training or a discriminatory labour market. Users' discount rates (A3) in relation to a particular forest may be low because they have lived for a long time in a particular location and expect that they and their grandchildren will remain in that location, or because they possess a secure and well-defined bundle of property rights to this forest (see Schlager and Ostrom 1992). Reliable indicators of the condition of a forest (R2) may result from activities of users themselves – such as regularly harvesting of medicinal plants or because of efforts to gather reliable information by users or by external authorities (Blomquist 1992). Predictability of forest resources (R3) may result from relatively constant weather conditions or because of actions taken by users to even out the availability of forest products over time. They may have autonomy to make their own rules (A6) because a national government is weak and unable to exert authority over forests that it formally owns, or because national law formally legitimates self-governance of forests as in Uttar Pradesh in India.

When the benefits of organising are commonly understood by participants to be very high, users lacking many of the attributes conducive to the development of self-governing institutions may be able to overcome their liabilities and still develop effective agreements. The crucial factor is not whether all attributes are favourable but the relative size of the expected benefits and costs they generate as perceived by participants. While all of these variables affect the expected benefits and costs of users, it is difficult – particularly for outsiders – to estimate their impacts given the difficulty of making precise measures of these variables and weighing them on a cumulative scale. Further empirical analysis of these theoretical propositions is, thus, dependent on the conduct over time of careful comparative studies of a sufficiently large number of field settings using a common set of measurement protocols (see E. Ostrom and Wertime 1994).

ON THE DESIGN PRINCIPLES OF ROBUST, SELF-GOVERNED COMMON-POOL RESOURCE INSTITUTIONS

Of course, the performance of self-governed common-pool resource institutions varies across systems and time. Some self-governed resources have survived and flourished for centuries, while others have faltered and failed. As discussed above, some never get organised in the first place. In addition to the consensus concerning the theoretical variables conducive to self-organisation, considerable agreement also exists about the

characteristics of those self-governing systems that are robust in the sense that they survive for very long periods of time utilising the same basic rules for adapting to new situations over time (Shepsle 1989).

The particular rules used in the long-surviving, self-governing systems vary substantially. Consequently, it is not possible to arrive at empirical generalisations about the particular types of rules used to define who is a member of a self-governing community, what rights they have to access a resource, and what particular obligations they face. It is possible, however, to derive a series of design principles that characterise the configuration of rules that are used. By design principles, I mean a condition that helps to account for the success of these institutions in sustaining a forest or other common-pool resource and gaining the compliance of generation after generation of users to the rules applied in a location. Based on considerable research on common-pool resources, robust, long-term institutions are characterised by most of the design principles listed in Table 1. Fragile institutions tend to be characterised by only some of these design principles. Failed institutions are characterised by very few of these principles (see, for example, Blomqvist 1996; Morrow and Hull 1996; Schweik *et al.* 1997).

These principles work to enhance the shared understanding of participants of the structure of a resource and its users and of the benefits and costs involved in following a set of agreed-upon rules. Design Principle 1 – having rules that clearly define who has rights to use a resource and the boundaries of that resource – ensures that users can clearly identify anyone who does not have rights and take action against them.

Design Principle 2 involves two parts. The first is congruence between the rules that assign benefits and the rules that assign costs. The crucial issue here is that these rules be considered fair and legitimate by the participants themselves (see McKean 1992). In many settings, fair rules are those that keep a relatively proportionate relationship between the assignment of benefits and of costs. Otherwise, those who contribute time, funds and effort to sustaining a forest or other common-pool resource system resent the ‘unfair’ allocation of benefits to those carrying a lesser load. The whole distribution system can disintegrate if it is not perceived as fair. The second part of this design principle is that both types of rules need to be well matched to local conditions, such as soils, slope, number of diversions, crops being grown.

Table 1. Design principles illustrated by long-enduring common-pool resource institutions

Principle	Explanation
1. Clearly defined boundaries	Individuals or households with rights to withdraw resource units from the common-pool resource and the boundaries of the common-pool resource itself are clearly defined.
2. Congruence	a. The distribution of benefits from appropriation rules is roughly proportionate to the costs imposed by provision rules. b. Appropriation rules restricting time, place, technology and/or quantity of resource units are related to local conditions.
3. Collective-choice arrangements	Most individuals affected by operational rules can participate in modifying operational rules.
4. Monitoring	Monitors, who actively audit common-pool resource conditions and user behaviour, are accountable to the users and/or are the users themselves.
5. Graduated sanctions	Users who violate operational rules are likely to receive graduated sanctions (depending on the seriousness and context of the offence) from other users, from officials accountable to these users, or from both.
6. Conflict-resolution mechanisms	Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.
7. Minimal recognition of rights to organise	The rights of users to devise their own institutions are not challenged by external governmental authorities.
For common-pool resources that are part of larger systems:	
8. Nested enterprises	Appropriation, provision, monitoring, enforcement, conflict resolution and governance activities are organised in multiple layers of nested enterprises.

Source: adapted from: E. Ostrom (1990: 90)

Design Principle 3 is concerned with the collective-choice arrangements used to modify operational rules – those that directly affect where, when and who can harvest from a resource. If most users are not involved in modifying these rules over time, the information about the benefits and costs as perceived by different participants is not fully taken into account in any efforts to adapt to new conditions and information over time. Users who begin to perceive the costs of their system being higher than their benefits, and who are prevented from making serious proposals for change, may simply begin to cheat whenever they have the opportunity. Once cheating on rules becomes more frequent for some users, others will follow suit. In this case, enforcement costs become very high or the system fails.

No matter how high the level of acceptance of an initial agreement, there are always conditions that tempt some individuals to cheat (even when they perceive the overall benefits of the system to be higher than the costs). If one person is able to cheat while others conform to the rules, the cheater is usually able to gain substantially to the disadvantage of others. Thus, without monitoring of rule conformance – Design Principle 4 – few systems are able to survive very long. The sanctions that are used, however, do not need to be extremely high in the first instance. The important thing about a sanction for a user who has succumbed to temptation is that their action is noticed and that a punishment is meted out. This tells all users that cheating on rules is noticed and punished without making all rule infractions into major criminal events. If the sanctions are graduated (Design Principle 5), a user who breaks rules repeatedly and who is noticed doing so, eventually faces a penalty that makes rule breaking an unattractive option. While rules are always assumed to be clear and unambiguous in theoretical work, this is rarely the case in field settings. It is easy to have a disagreement about how to interpret a rule that limits harvesting or requires inputs. If these disagreements are not resolved in a low-cost and orderly manner, then users may lose their willingness to conform to rules because of the ways that ‘others’ interpret them in their own favour (Design Principle 6).

Design Principles 7 and 8 are related to autonomy. When the rights of a group to devise their own institutions are recognised by national, regional and local governments, the legitimacy of the rules crafted by users will be less frequently challenged in courts, administrative and legislative settings. Further, in larger resources with many participants, such as many forests, nested enterprises that range in size from small to large enable participants to solve diverse problems involving different scale economies. By utilising base institutions that are quite small, face-to-face communication can be used for

solving many of the day-to-day problems in smaller groups. By nesting each level of organisation in a larger level, externalities between groups can be addressed in larger organisational settings that have a legitimate role to play in relationship to the smaller entities.

THEORETICAL PUZZLES

In addition to the consensus concerning the variables most likely to enhance self-organisation and the design principles characterising successful, long-term governance arrangements, many unresolved theoretical issues still exist about the self-governance of common-pool resources. Two major theoretical questions relate to the effect of size and heterogeneity.

Size

The effect of the number of participants facing problems of creating and sustaining a self-governing enterprise is unclear. Drawing on the early work of Mancur Olson (1965), many theorists argue that size of a group is negatively related to solving collective-action problems in general (see also Buchanan and Tullock 1962). Many results from game theoretical analysis of repeated games conclude that cooperative strategies are more likely to emerge and be sustained in smaller rather than larger groups (see synthesis of this literature in Baland and Platteau 1996). Scholars who have studied many user-governed forestry institutions in the field have concluded that success will more likely happen in smaller groups (see, for example, Cernea 1989).

In a systematic study of forest institutions, Agrawal (1998) has found that smaller forest user groups are less able to undertake the level of monitoring needed to protect forest resources than moderately sized groups. In a study of over 100 irrigation systems, Lam (1998) did not find any significant relationship between either the number of users or the amount of land included in the service area and any of the three performance variables he studied.

One of the problems of focussing on size of group as a key determining factor is that many other variables change as group size increases (Chamberlin 1974; R. Hardin 1982). If the costs of providing a public good related to the use of a forest, say a sanctioning system, remain relatively constant as group size increases, then increasing the number of participants brings additional resources that could be drawn upon to provide the benefit enjoyed by all (see Isaac *et al.* 1993). Marwell and Oliver (1993: 45) conclude that when a ‘good has pure jointness of supply, group size has a *positive* effect on the probability that it will be provided’. On the other

hand, if one is analysing the conflict levels over a subtractable good and the transaction costs of arriving at acceptable allocation formulae, group size may well exacerbate the problems of self-governing systems. Since there are tradeoffs among various impacts of size on other variables, a better working hypothesis is that medium-sized groups may succeed more often than very small or very large groups.

Heterogeneity

Many scholars conclude that only very small groups can organise themselves effectively because they presume that size is related to the homogeneity of a group and that homogeneity is needed to initiate and sustain self-governance. Heterogeneity is also a highly contested variable. Groups can vary along a diversity of dimensions including their cultural backgrounds, interests and endowments (see Baland and Platteau 1996). Each may operate differently. Further, groups who are relatively homogeneous may also find themselves confronted with high levels of conflict when rules related to access to forest resources are not well defined (see Gibson and Koontz forthcoming).

If groups from diverse cultural backgrounds share access to a forest, the key question affecting the likelihood of self-organised solutions is whether the views of the multiple groups concerning the structure of the forest, authority, interpretation of rules, trust and reciprocity differ or are similar. In other words, do they share a common understanding (A2) of their situation? New settlers to a region may simply learn and accept the rules of the established group, and their cultural differences on other fronts do not affect their participation in governing a forest. On the other hand, new settlers are frequently highly disruptive to the sustenance of a self-governing enterprise when they generate higher levels of conflict over the interpretation and application of rules and increase enforcement costs substantially.

When the interests of users differ, achieving a self-governing solution is particularly challenging. This problem characterises some fisheries where local subsistence fishermen have strong interests in the sustenance of an inshore fishery, while industrial fishing firms have many other options and may be more interested in the profitability of fishing in a particular location than its sustained yield. The conflict between absentee livestock owners and local pastoralists has also proved difficult to solve in many parts of the world.

Differential endowments of users can be associated with both extreme levels of conflict as well as very smooth

and low-cost transitions into a sustainable, self-governed system. Johnson and Libecap (1982) reason that the difference in the skills and knowledge of different kinds of users frequently prevents them from arriving at agreements about how to allocate harvesting quotas. Heterogeneity of wealth or power may or may not be associated with a difference in interests. As discussed above, when those who have more assets share similar interests with those who have less assets (A4), groups may be privileged by having the more powerful take on the higher initial costs of organising, while crafting rules that benefit a large proportion of the users. Users may design institutions that cope effectively with heterogeneities. Thus, when they adopt rules that allocate benefits using the same formulae used to allocate duties and responsibilities (Design Principle 2A), users who differ significantly in terms of assets will tend to agree to and follow such rules.

Even in a group that differs on many variables, if at least a minimally winning subset of users from an endangered but valuable forest are dependent on it (A1), and they share a common understanding of their situations (A2), have a low discount rate (A3), include some with more assets among their members (A4), trust one another (A5), and have autonomy to make their own rules (A6), it is more likely that they will estimate the expected benefits of governing their forest to be greater than the expected costs. Whether the rules agreed upon distribute benefits and costs fairly depends both on the collective-choice rule used and the type of heterogeneity existing in the community. Neither size nor heterogeneity is a variable with a uniform effect on the likelihood of organising and sustaining self-governing enterprises. The debate about their effect is focussing on the wrong variables. Instead of concentrating on size or the various kinds of heterogeneity independently, it is important to ask how these variables influence other variables as they affect the benefit-cost calculations of those involved in negotiating and sustaining agreements. Their impact on costs of producing and distributing information (Scott 1993) is particularly important.

CONCLUSION

The conventional theory of common-pool resources, which presumed that external authorities were needed to impose new rules on those users trapped into producing excessive externalities for themselves and others, has now been shown to be a special theory of a more general theoretical structure. For users to contemplate changing the institutions they face, they have to conclude that the expected benefits from an institutional change will exceed the immediate and long-term expected costs.

When users cannot communicate and have no way of gaining trust through their own efforts or with the help of the macroinstitutional system within which they are embedded, the prediction of the earlier theory is likely to be empirically supported. Ocean fisheries, the stratosphere and other global commons come closest to the appropriate empirical referents. If users can engage in face-to-face bargaining and have autonomy to change their rules, they may well attempt to organise themselves. Whether they organise depends on attributes of the resource and the users themselves that affect the benefits to be achieved and the costs of achieving them. Whether their self-governed enterprise succeeds over the long term depends on whether the institutions they develop are consistent with design principles underlying robust, long-living, self-governed systems. The theory has progressed substantially during the past half century.

There are, however, many challenging puzzles to be solved.

Further empirical research is needed to test the relevance and explanatory power for forests of the emerging consensus regarding the conditions conducive to effective self-governance of resources and for the design of more effective public policies. Given the number of variables that can independently and interactively affect the incentives and actions of local users – especially when one focuses on forest resources – systematic research conducted in a large number of locations obtaining data about the same set of variables is also extremely important. Hopefully, future policies will be constructed on the basis of an understanding of both the strengths and limitations of self-governance of forestry resources.

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REFERENCES

- Agrawal, A. 1998 Group size and successful collective action: a case study of forest management institutions in the Indian Himalayas. *In*: Gibson, C., McKean, M. and Ostrom, E. (eds.) *Forest resources and institutions*. Forests, Trees And People Programme, Working Paper 3. FAO, Rome, Italy.
- Agrawal, A. Forthcoming Greener pastures: exchange, politics and community among a mobile people. Duke University Press, Durham, NC.
- Agrawal, A. and Yadama, G. 1997 How do local institutions mediate market and population pressures on resources: forest *Panchayats* in Kumaon, India. *Development and Change* 28: 435-65.
- Alcorn, J. 1990 Indigenous agroforestry strategies meeting farmers' needs. *In*: Anderson, A. (ed.) *Alternatives to deforestation: steps toward sustainable use of Amazon Rainforest*, 141-151. Columbia University Press, New York.
- Arnold, J.E.M. 1997 Social dimensions of forestry's contribution to sustainable development. Position Paper for programme area F of the XI World Forestry Congress, Antalya, Turkey, 13-22 October 1997.
- Arnold, J.E.M. 1998 Devolution of control of common pool resources to local communities: experiences in forestry. Paper presented at the meeting of the UNU/WIDER Project on Land Reform Revisited: Access to Land, Rural Poverty, and Public Action, Santiago, Chile, April 26-28.
- Arnold, J.E.M. and Campbell, J.G. 1986 Collective management of hill forests in Nepal: the community forestry development project. *In*: National Research Council, *Proceedings of the conference on Common Property Resource Management*, 425-54. National Academy Press, Washington, DC.
- Arnold, J.E.M. and Stewart, W.C. 1991 *Common property resources management in India*. Oxford Forestry Institute, Tropical Forestry Papers 24. Oxford University, Oxford, UK.
- Ascher, W. 1995 *Communities and sustainable forestry in developing countries*. ICS Press, Oakland, CA.
- Baland, J.M. and Platteau, J.P. 1996 *Halting degradation of natural resources. Is there a role for rural communities?* Clarendon Press, Oxford, UK.
- Banana, A.Y. and Gombya-Ssembajjwe, W. 1998 Successful forest management: the importance of security of tenure and rule enforcement in Ugandan forests. *In*: Gibson, C., McKean, M. and Ostrom, E. (eds.) *Forest resources and institutions*. Forests, Trees And People Programme, Working Paper 3. FAO, Rome, Italy.
- Bebbington, A, Kopp, A. and Rubinoff, D. 1997 From chaos to strength? Social capital, rural people's organizations and sustainable development. Paper prepared for the FAO workshop on Pluralism, Forestry And Rural Development, December 1997, Rome, Italy.
- Becker, C.D. and Gibson, C. 1998 The lack of institutional supply: why a strong local community in Western Ecuador fails to protect its forest. *In*: Gibson, C., McKean, M. and Ostrom, E. (eds.) *Forest resources and institutions*. Forests, Trees And People Programme, Working Paper 3. FAO, Rome, Italy.
- Becker, C.D., Banana, A.Y. and Gombya-Ssembajjwe, W. 1995 Early detection of tropical forest degradation: an IFRI pilot study in Uganda. *Environmental Conservation* 22: 31-38.
- Berkes, F. 1986 Local-level management and the commons problem: a comparative study of Turkish coastal fisheries. *Marine Policy* 10: 215-29.
- Berkes, F. (ed.) 1989 *Common property resources: ecology and community-based sustainable development*. Belhaven Press, London, UK.

- Berkes, F., Feeny, D., McCay, B.J. and Acheson, J.M. 1989 The benefits of the commons. *Nature* 340: 91-3.
- Blomquist, W. 1992 *Dividing the waters: governing groundwater in southern California*. ICS Press, Oakland, CA
- Blomqvist, A. 1996 *Food and fashion. Water management and collective action among irrigation farmers and textile industrialists in South India*. The Institute of Tema Research, Department of Water and Environmental Studies, Linköping, Sweden.
- Bromley, D.W., Feeny, D., McKean, M., Peters, P., Gilles, J., Oakerson, R., Runge, C.F. and Thomson, J. (eds.) 1992 *Making the commons work: theory, practice, and policy*. ICS Press, Oakland, CA.
- Buchanan, J.M. and Tullock, G. 1962 *The calculus of consent*. University of Michigan Press, Ann Arbor, MI.
- Cernea, M. 1989 *User groups as producers in participatory afforestation strategies*. World Bank Discussion Papers 70. World Bank, Washington, DC.
- Chamberlin, J. 1974 Provision of collective goods as a function of group size. *American Political Science Review* 68: 707-16.
- Coleman, J. 1988 Social capital in the creation of human capital. *American Journal of Sociology* 91: 309-35.
- Dasgupta, P.S. and Heal, G.M. 1979 *Economic theory and exhaustible resources*. Cambridge University Press, Cambridge, UK.
- Dawes, R.M. 1973 The commons dilemma game: an N-person mixed-motive game with a dominating strategy for defection. *Oregon Research Institute Research Bulletin* 13: 1-12.
- Demsetz, H. 1967 Toward a theory of property rights. *American Economic Review* 57: 347-59.
- Fairhead, J. and Leach, M. 1996 *Misreading the African landscape. Society and ecology in a forest-savanna mosaic*. Cambridge University Press, Cambridge, UK.
- Feeny, D., Hanna, S. and McEvoy, A.F. 1996 Questioning the assumptions of the 'tragedy of the commons' model of fisheries. *Land Economics* 72: 187-205.
- Fisher, R. J. 1988 *Indigenous systems of common property forest management in Nepal*. Environment and Policy Institute, Working Paper 18. East West Center, University of Hawaii, Honolulu.
- FAO (Food and Agriculture Organization) 1997 *Crafting institutional arrangements for community forestry. Community Forestry Field Manual 7*. FAO, Rome, Italy.
- Ford Foundation. 1998 *Forestry for sustainable rural development*. Ford Foundation, New York.
- Fortmann, L. and Bruce, J.W. (eds.) 1988 *Whose trees? Proprietary dimensions of forestry*. Westview Press, Boulder, CO.
- Fox, J. (ed.) 1993 *Legal frameworks for forest management in Asia: case studies of community/State relations*. Program on Environment, Occasional Paper 16. East West Center, University of Hawaii, Honolulu.
- Gibson, C. and Koontz, T. Forthcoming *When 'community' is not enough: institutions and values in community-based forest management in Southern Indiana*. *Human Ecology*.
- Gibson, C., McKean, M. and Ostrom, E. (eds.) 1998 *Forest resources and institutions*. Forests, Trees And People Programme, Working Paper 3. FAO, Rome, Italy.
- Gillis, M. 1988 *Indonesia: public policies, resource management, and the tropical forest*. In: Repetto, R. and Gillis, M. (eds.) *Public policies and the misuse of forest resources*, 43-113. Cambridge University Press, New York.
- Gilmour, D.A. and Fisher, R.J. 1992 *Villagers, forests, and foresters: the philosophy, process, and practice of community forestry in Nepal*. Sahayogi Press, Kathmandu, Nepal.
- Hardin, G. 1968 The tragedy of the commons. *Science* 162: 1243-8.
- Hardin, R. 1982 *Collective action*. Johns Hopkins University Press, Baltimore, MD.
- Herring, R.J. 1990 Rethinking the commons. *Agriculture and Human Values* 7(2): 88-104.
- IASCP (International Association for the Study of Common Property) 1998 *Abstracts of the workshop Crossing Boundaries, Seventh Common Property Conference, held in Vancouver, Canada, 10-14 June 1998*.
- Isaac, R.M., Walker, J. and Williams, A. 1993 Group size and the voluntary provision of public goods: experimental evidence utilizing large groups. *Journal of Public Economics* 54: 1-36.

- Jodha, N.S. 1986 Common property resources and rural poor in dry regions of India. *Economic and Political Weekly*, 21(27): 1169-81.
- Johnson, R.N. and Libecap, G.D. 1982 Contracting problems and regulation: the case of the fishery. *American Economic Review* 72: 1005-23.
- Lam, W.F. 1998 Governing irrigation systems in Nepal: institutions, infrastructure, and collective action. ICS Press, Oakland, CA.
- Leach, M., Mearns, R. and Scoones, I. 1997 Challenges to community-based sustainable development: dynamics, entitlements, institutions. *IDS Bulletin*. 28(4): 4-14.
- Libecap, G.D. and Wiggins, S.N. 1985 The influence of private contractual failure on regulation: the case of oil field unitization. *Journal of Political Economy* 93: 690-714.
- Lynch, O. and K. Talbott. 1995 *Balancing acts: community-based forest management and national law in Asia and the Pacific*. World Resources Institute, Washington, DC.
- Malla, Y.B. 1997 Sustainable use of communal forests in Nepal. *Journal of World Resource Management*. 8:51-74.
- Marwell, G. and Oliver, P. 1993 *The critical mass in collective action: a micro-social theory*. Cambridge University Press, New York.
- McCay, B.J. and Acheson, J.M. 1987 *The question of the commons: the culture and ecology of communal resources*. University of Arizona Press, Tucson, AZ.
- McKean, M. and E. Ostrom. 1995 Common property regimes in the forest: just a relic from the past? *Unasylva*, 46(180): 3-15
- McKean, M.A. 1992 Management of traditional common lands (*Iriaichi*) in Japan. *In: Bromley, D.W., Feeny, D., McKean, M., Peters, P., Gilles, J., Oakerson, R., Runge, C.F. and Thomson, J. (eds.) Making the commons work: theory, practice, and policy*, 63-98. ICS Press, Oakland, CA.
- McKean, M.A. 1998 Common property: what is it, what is it good for, and what makes it work? *In: Gibson, C., McKean, M. and Ostrom, E. (eds.) Forest resources and institutions. Forests, Trees And People Programme, Working Paper 3*. FAO, Rome, Italy.
- Messerschmidt, D.A. (ed.) 1993 *Common forest resource management: annotated bibliography of Asia, Africa, and Latin America*. Community Forestry Note 11. FAO, Rome, Italy.
- Morrow, C.E. and Hull, R.W. 1996 Donor-initiated common pool resource institutions: the case of the Yanasha forestry cooperative. *World Development* 24: 1641-57.
- Moxnes, E. 1996 Not only the tragedy of the commons: misperceptions of bioeconomics. Working Paper, Foundation for Research in Economics and Business Administration. SNF, Bergen, Norway.
- National Research Council 1986 *Proceedings of the conference on Common Property Resource Management*. National Academy Press, Washington, DC.
- Netting, R. McC. 1972 Of men and meadows: strategies of alpine land use. *Anthropological Quarterly* 45: 132-44.
- North, D. 1990 *Institutions, institutional change and economic performance*. Cambridge University Press, New York.
- Okoth-Ogendo, H.W.O. 1987 Tenure of trees or tenure of land. *In: Raintree, J. (ed.) Land, trees and tenure: proceedings of an international workshop on tenure issues in agroforestry, Nairobi, May 27- 31, 1985*, 225-229. Land Tenure Center, Madison, WI.
- Olson, M. 1965 *The logic of collective action: Public goods and the theory of groups*. Harvard University Press, Cambridge, MA.
- Ophuls, W. 1973 Leviathan or oblivion. *In: Daly, H.E. (ed.) Toward a steady state economy*. Freeman, Oakland, CA.
- Ostrom, E. 1990 *Governing the commons: the evolution of institutions for collective action*. Cambridge University Press, New York.
- Ostrom, E. 1992a *Crafting institutions for self-governing irrigation systems*. ICS Press, Oakland, CA.
- Ostrom, E. 1992b The rudiments of a theory of the origins, survival, and performance of common-property institutions. *In: Bromley, D.W., Feeny, D., McKean, M., Peters, P., Gilles, J., Oakerson, R., Runge, C.F. and Thomson, J. (eds.) Making the commons work: theory, practice, and policy*, 293-318. ICS Press, Oakland, CA.

- Ostrom, E. 1996 Crossing the great divide: coproduction, synergy, and development. *World Development* 24: 1073-1087.
- Ostrom, E. 1998 The international forestry resources and institutions research program: a methodology for relating human incentives and actions on forest cover and biodiversity. *In: Dallmeier, F. and Comiskey, J.A. (eds.) Forest biodiversity in North, Central and South America, and the Caribbean: Research and Monitoring. Man and the Biosphere Series, 22.* Unesco, Paris, France and The Parthenon Publishing Group, Carnforth, UK.
- Ostrom, E. and Wertime, M.B. 1994 International forestry resources and institutions (IFRI) research strategy. Working Paper, Workshop in Political Theory and Policy Analysis. Indiana University, Bloomington, IN.
- Ostrom, E., Gardner, R. and Walker, J.M. 1994 Rules, games, and common-pool resources. University of Michigan Press, Ann Arbor, MI.
- Ostrom, V. 1991 The meaning of American Federalism: constituting a self-governing society. ICS Press, Oakland, CA.
- Ostrom, V. 1997 The meaning of democracy and the vulnerability of democracies: a response to Tocqueville's challenge. University of Michigan Press, Ann Arbor, MI.
- Peluso, N.L. 1996 Fruit trees and family trees in an anthropogenic forest: ethics, of access, property zones, and environmental change in Indonesia. *Comparative Studies in Society and History* 38: 510-48.
- Peluso, N.L. and Poffenberger, M. 1989 Social forestry in Java: reorienting management systems. *Human Organization* 48:333-44.
- Peters, P. 1994. Dividing the commons: politics, policy, and culture in Botswana. University of Virginia, Charlottesville, VA.
- Poffenberger, M. (ed.) 1990 Keepers of the forest: land management alternatives in Southeast Asia. Kumerian Press, West Hartford, CT.
- Posner, R. 1977 Economic analysis of law. Little, Brown & Co, Boston, MA.
- Richards, M. 1997 Common property resource institutions and forest management in Latin America. *Development and Change* 28: 95-117
- Rocheleau, D. and Ross, L. 1995 Trees as tools, trees as text: struggles over resources in Zambra-Chacuey, Dominican Republic. *Antipode* 27: 407-428.
- Sarin, M. 1993 From conflict to collaboration: local institutions in joint forest management. Joint Forest Management Working Paper 14. Society for the Promotion of Wastelands Development and Ford Foundation, New Delhi, India.
- Schlager, E. 1990 Model specification and policy analysis: the governance of coastal fisheries. PhD dissertation, Indiana University, Bloomington, IN.
- Schlager, E. and Ostrom, E. 1992 Property-rights regimes and natural resources: a conceptual analysis. *Land Economics* 68: 249-62.
- Schweik, C.M. 1998 Social norms and human foraging: an investigation into the spatial distribution of *Shorea robusta* in Nepal. *In: Gibson, C., McKean, M. and Ostrom, E. (eds.) Forest resources and institutions. Forests, Trees And People Programme, Working Paper 3.* FAO, Rome, Italy.
- Schweik, C.M., Adhikari, K. and Pandit, K.N. 1997 Land-cover change and forest institutions: a comparison of two sub-basins in the southern Siwalik hills of Nepal. *Mountain Research and Development* 17: 99-116.
- Scott, A.D. 1993 Obstacles to fishery self-government. *Marine Resource Economics* 8: 187-99.
- Shepherd, G. 1992 Managing Africa's tropical dry forests: a review of indigenous methods. Agricultural Occasional Paper 14. Overseas Development Institute, London, UK.
- Shepsle, K.A. 1989 Studying institutions: some lessons from the rational choice approach. *Journal of Theoretical Politics* 1: 131-49.
- Shivakoti, G., Varughese, G., Ostrom, E., Shukla, A. and Thapa, G. (eds.) 1997 People and participation in sustainable development: understanding the dynamics of natural resource systems. Proceedings of an international conference on Political Theory and Policy Analysis held at the Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal, March 17-21 1996. Indiana University, Bloomington, IN.

- Simmons, R.T., Smith, F.L., Jr. and Georgia, P. 1996 The tragedy of the commons revisited: politics versus private property. The Center for Private Conservation, Washington, DC.
- Tang, S.Y. 1992 Institutions and collective action: self-governance in irrigation. ICS Press, Oakland, CA.
- Thompson, L.L., Mannix, E.A. and Bazerman, M.H. 1988 Negotiation in small groups: effects of decision rule, agendas and aspirations. *Journal of Personality and Social Psychology* 54: 86-95.
- Varughese, G. 1998 Coping with changes in population and forest resources: institutional mediation in the middle hills of Nepal. *In: Gibson, C., McKean, M. and Ostrom, E. (eds.) Forest resources and institutions. Forests, Trees And People Programme, Working Paper 3.* FAO, Rome, Italy.
- Wade, R. 1994 Village republics: economic conditions for collective action in South India. ICS Press, Oakland, CA.
- Walker, J.M., Gardner, R., Ostrom, E. and Herr, A. 1997 Voting on allocation rules in a commons: theoretical issues and experimental results. Working Paper, Workshop in Political Theory and Policy Analysis. Indiana University, Bloomington, IN.
- Western, D. and Wright, R.M. (eds.) 1995 Natural connections: perspectives in community-based conservation. Island Press, Washington, DC.
- Wilson, P.N. and Thompson, G.D. 1993 Common property and uncertainty: compensating coalitions by Mexico's pastoral Ejidatarios. *Economic Development and Cultural Change* 41: 299-318.
- World Bank. 1992 World Development Report 1992. Development and the environment. World Bank, Washington, DC.