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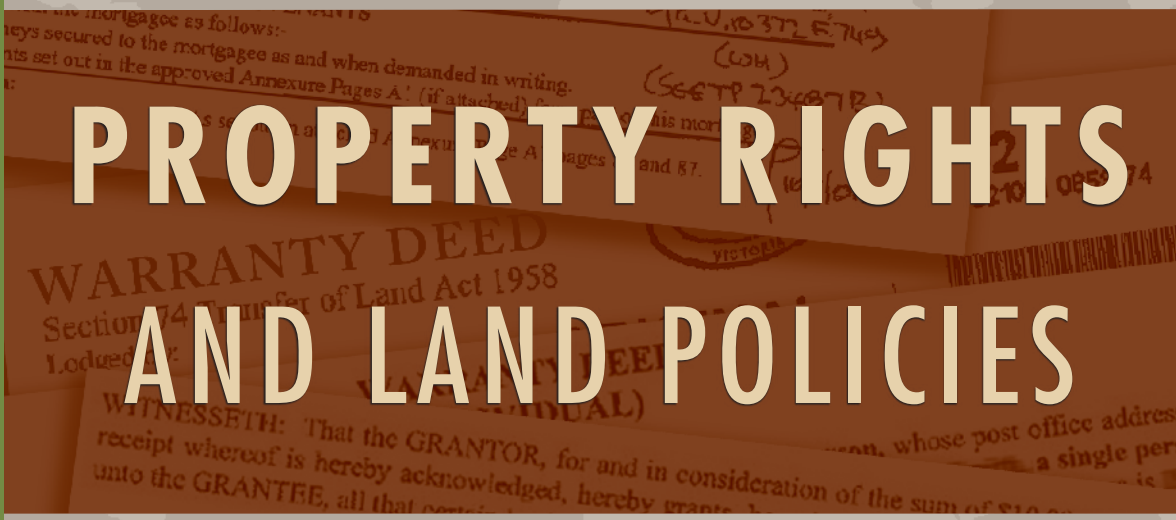

PROPERTY RIGHTS AND LAND POLICIES

Edited by Gregory K. Ingram and Yu-Hung Hong

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Design Principles of Robust Property Rights Institutions: What Have We Learned?

Elinor Ostrom

The Problem of Open Access

The problem of overuse of open-access resources was clearly articulated by Scott Gordon (1954) and Harold Demsetz (1967). Garrett Hardin (1968) speculated about the same problem, but stressed that the resource users themselves were trapped in tragic overuse and that solutions had to be imposed from the outside. Gordon, Demsetz, and Hardin ignited a general concern that when property rights related to a valuable resource did not exist, the resources would be overharvested.

Because of the existence of sufficient empirical examples of the problems facing users of land-based common-pool resources given the independence of actors in the absence of property rights, the empirical applicability of the theory was not challenged until the mid-1980s. For many observers, massive deforestation in tropical countries and the collapse of many ocean fisheries confirmed the worst predictions to be derived from this theory (Hutchings 2000; Jackson et al. 2001; Rudel 2005). Since harvesters are viewed as being trapped in these dilemmas, repeated demands that external authorities impose a different set of institutions on such settings have been made. Predictions of overharvesting have also been supported in the experimental laboratory when subjects made anonymous decisions and

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were not allowed to communicate with one another, but not when they were able to engage in face-to-face communication (Ostrom, Gardner, and Walker 1994).

Solving the Problem by Recommending Optimal Institutions

Many policy analysts have recommended a single optimal policy for solving the open-access problem. Some recommended private property as the most efficient form of ownership, as did Demsetz himself (Posner 1977; Raymond 2003). Others recommended government ownership and control (Lovejoy 2006; Terborgh 1999, 2000), even though it is difficult for a bureaucracy to make rational decisions given the high level of uncertainty involved in most resources (Whitford 2002). Grafton (2000) made a more nuanced argument for the state in governing resources, sometimes as the owner of a resource and sometimes providing good backup to those engaged in collective action. Theorists frequently implicitly assumed that regulators would act in the public interest and that they knew how ecological systems work and how to change institutions so as to induce socially optimal behavior (Feeny, Hanna, and McEvoy 1996, 195).

Unfortunately, many of the recommended optimal institutions are little more than stylized figures based on the underlying simple models that Gordon and Demsetz developed. Colin Clark (2006, 15) reflected on the power of these simple models to clearly illustrate the deep problems of overharvesting. The underlying "stick figures," however, are too simplistic for analysis that adequately captures the dynamics of all common-pool resources. Applying rules that bring the costs of harvesting up to the level that would induce sustainable yield is a simple solution when modeling, but not at all simple when faced with the complexity of field settings.

Self-Organized Development of Property Rights

The possibility that the users of a resource would find ways to organize themselves was not considered in most economics, natural resource, and property rights literature until the last three decades. Organizing so as to create rules that specify rights and duties of participants creates a public good for those involved. Everyone included in the community of users benefits from this public good, whether they contribute or not. Getting "out of the trap" is itself a second-level social dilemma. Investing in diverse mechanisms to increase the likelihood that participants follow the rules they make also generates a public good. These investments represent a third-level social dilemma. Since the initial problem exists because the individuals are supposed to be stuck in a setting where they generate negative externalities on one another, it is not consistent with the conventional theory that they solve second- and third-level social dilemmas in order to address the first-level dilemma under analysis.

In the decades after Scott's, Demsetz's, and Hardin's famous articles, however, multiple empirical studies about common-pool resources have been un-

dertaken (Berkes 1989, 2007; Dolšak and Ostrom 2003; McCay and Acheson 1987; National Research Council 1986, 2002). As a result of these studies, we now know that some (but not all) individuals who jointly use a common-pool resource will

- expend considerable time and energy trying to develop workable rules that they can use for governing and managing a resource;
- follow their own costly rules so long as they believe that most of the others affected also follow these rules;
- monitor each other's conformance with these rules; and
- impose sanctions on those who break rules at a cost to themselves.

Conventional economic theory would not lead to a prediction that anyone would undertake these four actions based on a model of maximization of short-term individual returns. Thus, to move our understanding ahead of earlier theories, it is necessary to dig into what we mean by property rights and how resource users may design their own property rights systems. Then, we need to examine an earlier effort to understand why some property rights systems were robust over long periods of time while others collapsed—the possibility that broad design principles underlay the successful efforts (Ostrom 1990). We then discuss a recent analysis of scholars' assessment of the usefulness of these design principles and conclude with an analysis of how the design principles should be revised in light of multiple studies and how we can use the design principles in practice without using them as blueprints.

What Are Property Rights?

One of the confusions related to the existence of property rights is that scholars have sometimes limited the concept of property rights to the existence of a right by one party (individual, family, organized group, or government) to sell all of the rights to some other party. Selling one's rights is frequently referred to as "alienation." Some scholars presumed that unless users had alienation rights, they did not have any property rights. Some of the early confusion about the capability of users to develop their own effective governance system related to the presumption that without the right of alienation, resource users had no property rights and were indeed trapped in overuse. After the first National Research Council report in 1986, we began collecting case studies written by historians, anthropologists, engineers, political scientists, economists, and other social scientists and started the challenging task of coding them systematically in the common-pool resources (CPR) database housed at the Workshop in Political Theory and Policy Analysis at Indiana University (for a description, see Ostrom, Gardner, and Walker 1994; Schlager 1990; and Tang 1992 for a general description of the effort, and Poteete and Ostrom 2008 for an overview of the challenge of doing a meta-analysis of the large number of relevant cases).

As we worked on this meta-analysis of governance systems related to common-pool resources, we kept finding established resource systems that had survived for long periods of time in which the users did not have the right to sell their holdings. This led Edella Schlager and me (1992) to draw on the earlier insights of Ciriacy-Wantrup and Bishop (1975) and Commons (1968) and to think of property rights systems in terms of bundles of rights rather than as a single right. We defined the following five rights that we found in empirical studies of operational resource systems in the field:

1. Access—a right to enter a defined physical property
2. Withdrawal—a right to harvest the products of a resource such as timber, water, and food for pastoral animals
3. Management—a right to regulate the use patterns of other harvesters and to transform a resource system by building improvements
4. Exclusion—a right to determine who will have the right of access to a resource and whether that right can be transferred
5. Alienation—a right to sell or lease any of the above rights

Schlager and Ostrom (1992) posed the possibility that one can relate the different ways that these bundles are combined to a set of positions that individuals hold in regard to operational settings. For many resources, one can define five types of positions held by people who have some type of property right and obligations that are related to that right. A person who has only access rights can be called an authorized viewer. When a person enters a national or state forest, for example, with a one-day (or one-season) permit, he has a property right as an authorized viewer. He may have had to pay a fee to obtain this right, and he has obligations to follow the rules established by the forest authority. Most state forests, for example, do not allow a person who has a one-day or monthly permit to harvest anything. The person can sit at picnic grounds and enjoy the forest, but he is not supposed to litter the forest. He may be authorized to camp overnight. He can do all sorts of viewing, but he is not supposed to harvest trees, mushrooms, or other plants.

A person who has access and withdrawal rights can be called an authorized user. In many pastoral systems and fisheries, users have evolved recognized rights to harvest. Frequently, those rights are matched with obligations in regard to the timing of harvest, the equipment that may be used in harvesting, and the purpose for which the harvested units may be used.

A person with access, withdrawal, and management rights is called a claimant. Many common-property institutions recognize the rights and obligations of a claimant to build fences around a jointly owned forest, to improve an irrigation system by lining the canals, or to make others of a wide diversity of improvements that relate to the management of the system. The obligations involved in these property rights enable the holders to achieve a longer-term perspective as

a result of the investments they make in the long-term productivity and sustainability of the resource.

A person who has those three rights plus the right of exclusion is called a proprietor. A proprietor has substantial rights and obligations to regulate use, invest in the system, and determine who has access to the system.

Finally, the term *owner* identifies individuals who have all five rights and the obligations related to these rights. There are a variety of common-property institutions in which participants can sell any and all of their other bundles of rights to someone else. Sometimes they have to get permission from a council to do this, but they have that right subject to review. There are, however, many well-defined and operational common-property systems that have existed for a long time without the right of alienation (McKean 1982, 1992; Netting 1981).

Schlager (1994) analyzed the patterns of rights and outcomes for a set of inshore fishery cases that were well documented by the original case authors. She found that fishers from inshore fisheries who were claimants—who possessed the three rights of access, withdrawal, and management—had the capability to self-organize. Having the authority to exclude others (being proprietors) gave fishers even more capabilities to keep others from invading their inshore fishery and allowed still further investment in regulating use and investment. Schlager did not find that having the right of alienation was as essential as claimed in the literature.

In regard to irrigation systems, Tang (1994) found that having the rights of a proprietor made a substantial difference in regard to long-term management, but having the full rights of an owner was not crucial. In many common-property systems that have been sustained over long periods of time, none of the resource users has had the right to alienate their other rights. Thus, the right of alienation is not the key defining right for those who have been responsible for designing and adapting common-property systems in the field. Many users of common-pool resources do have property rights, even though these may not include the right of alienation.

Can Resource Users Create Their Own Property Rights?

While Hardin presumed that the users of a common-pool resource were hopelessly trapped in a system of overuse, the extensive research literature on common-property institutions provides strong evidence that the users are not always helpless (see overview in National Research Council 1986, 2002). In some legal systems—particularly those broadly based on Roman law traditions rather than English common law—the extent of autonomy to develop their own property rights systems granted to users of forests, irrigation systems, lakes, and inshore fisheries is restricted. Even in these systems, however, users of common-pool resource systems located in relatively remote settings have frequently (but not always) established some basic understanding of who was authorized to use the

resource, how resource units should be harvested from the resource, and what the agreed-upon uses of these resources were.[1]

To create their own set of rules about boundaries and use practices, a group of users must solve a basic collective action problem—the second-level social dilemma referred to above (Leach, Mearns, and Scoones 1997; Mehta et al. 1999). They face a long-term problem that if they do not find a way of limiting use, they will destroy a resource that may be of high value to the users' personal and family economic well-being. Just facing such a problem is, however, not a sufficient condition for positing that users will engage in collective action. Many theorists have presumed, as Hardin did, that those involved in a collective action problem would not themselves solve it, since social dilemmas involve a conflict between individual rationality and optimal outcomes for a group (Alchian and Demsetz 1972; Coase 1960; Lichbach 1996; Schelling 1978). Even if some individuals cooperate, the others are predicted to free ride on them.

In formal models of social dilemmas, assumptions are made that (1) decisions about strategies are made independently and simultaneously; (2) participants have common knowledge of an exogenously fixed structure of the situation and of the payoffs to participants; and (3) no external authority is present to enforce agreements among participants. When these assumptions are made for a one-shot game, the theoretical prediction derived from classical, noncooperative game theory is unambiguous—zero cooperation.[2] In repeated situations, there are many solution concepts that vary all the way from zero to full cooperation (Abreau 1988).

Fortunately, collective action theory has now matured. Instead of predicting that participants will never engage in cooperation or that anything can happen, there is growing agreement on the attributes of the users and of the structure of the situation that combine to enable predictions regarding the likelihood of participants' engaging in collective action (see Ostrom 2007a for an overview; Gibson et al. 2005; Marshall 2005). Some of the variables considered in the collective action literature include the size and heterogeneity of the group involved and how individuals are potentially linked, the type of production functions users are facing, the type of transaction costs that a group faces, how easy it is to get good information about the results of past actions, and how

1. Since many policy analysts have assumed that property rights have to be established by an external authority—the state—self-organized common-property systems are frequently invisible to them. They presume that, unless they find legal documents creating a property system, it does not exist. As more conservation policies have been adopted in the last several decades, they have frequently imposed new centralized institutions on indigenous peoples, leading in some cases to increased destruction of delicate ecosystems rather than to increased protection of them.

2. In a very large number of one-shot public good experiments undertaken in diverse countries, however, subjects tend to contribute an average of between 40 and 60 percent of the optimal level of contributions (Davis and Holt 1993, 325; Sally 1995).

valuable solving the problem is to participants. Developing trust and reciprocity is crucial to building the social capital needed to create workable property rights (Ahn and Ostrom 2008; Ostrom 1998). This chapter does not delve into the variables that increase the probability that a group of resource appropriators engages in collective action to create a set of property rights, which has been covered in several past works (Ostrom 1990, 2001, 2005). Here, the point is that it is now well established that some users of common-pool resources in settings that are conducive to self-organization do create their own common-property institutions.

The Robustness of Self-Organized Common-Property Institutions

Not only have common-property scholars documented the possibility that resource users would themselves overcome dilemmas to create their own institutions, but many of these institutions have survived for multiple years—even centuries in some instances. In the late 1980s, after working with colleagues to amass, read, and code a large number of individual cases of long-lasting and of failed systems, I tried valiantly to find the specific rules that were associated with the systems that had survived for long periods of time using Kenneth Shepsle's (1989) definition of a robust institution as one that was long-lasting and had operational rules that had been devised and modified over time according to a set of higher-level rules (which institutional analysts would usually call collective choice rules). These higher-level rules might themselves be modified slowly over time. The contemporary definition of robustness in regard to complex systems focuses on adaptability to disturbances: "the maintenance of some desired system characteristics despite fluctuations in the behavior of its component parts or its environment" (Carlson and Doyle 2002, 2538; see also Anderies, Janssen, and Ostrom 2004; Janssen and Anderies 2007).

I spent weeks and weeks reading cases, writing them up, redoing statistical analyses, and thinking that I was a dope for not being able to identify regularities in the specific property rights of the successful cases. Finally, the idea dawned on me that I should stop trying to identify the specific rules that tended to generate success. Perhaps what I needed to do was move up a level or two in generality to try to understand more general institutional regularities among the systems that were sustained over long periods of time. I did not even know what I should call those regularities. The idea finally dawned on me that one way of talking about them would be as design principles.

I did not think that the irrigators, fishers, forest dwellers, and others who had invented and sustained successful common-property regimes over several centuries had these principles overtly in their minds. Not all artists have training in art and know the principles they use in painting outstanding works of art. So I thought of these regularities as underlying principles that one could draw out from the cases of long-sustained regimes. I compared the successes with the

failures to assess whether the failures were characterized by the same principles. If they were, of course, the principles would not be a meaningful distinction between robust, long-surviving systems and systems that were not able to sustain themselves over time.

Thus, in *Governing the Commons* (Ostrom 1990), I laid out what I thought were eight key design principles related to long-term robustness of institutions crafted to govern common-pool resource systems. At the time, many colleagues read and commented on this effort and the cases used to derive and then illustrate the principles. I was uncertain that I had indeed identified the core set of principles, but I finally decided that I should share this analysis with other scholars so that they could challenge the findings, and we could develop a firmer foundation for better institutions in the future.

The Eight Design Principles Posited in 1990

Since I described these principles in some detail in previous publications (Ostrom 1990, 2005), a brief overview will serve as a basis for further discussion (see table 2.1).

CLEARLY DEFINED BOUNDARIES

The first design principle is that the boundaries of a resource system, as well as the individuals or households with property rights, are clearly defined. The boundary rules related to who can enter, harvest, manage, and potentially exclude others affect a participant's presumption about the likely levels of trustworthiness and cooperation of the others involved. If the rules are not well defined, strangers who discover a valuable resource may start to use it. Because they are strangers, they may overuse it. When long-standing participants fear that others may start using a resource of value to them, creating well-defined boundary rules helps immensely in increasing the probability that a person who is cooperating in limiting harvests and providing maintenance is not being a sucker because others are overharvesting and not contributing to the maintenance.

Having a clear boundary for the resource itself is important for a different set of reasons. It clarifies what is meant by a particular resource system. Where may I go, and where may I not go? The free riding problem is addressed by systems that define their boundaries. If a group of users can determine its own membership—including those who agree to use the resource according to the agreed-upon rules and excluding those who do not agree—the group has made an important first step toward limiting access and developing greater trust and reciprocity. Using this principle enables participants to know who is in and who is out of a defined set of relationships and, thus, with whom to cooperate.

Just defining the boundaries may not be sufficient in and of itself, especially when the boundaries are drawn by external officials. The boundaries of the Maya Biosphere Reserve located in the capital city of Guatemala are well defined on

Table 2.1
Design Principles for Governing Sustainable Resources Derived from Long-Enduring Studies of Institutions

1. *Clearly Defined Boundaries*
   The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.
2. *Proportional Equivalence Between Benefits and Costs*
   Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labor, materials, and/or money inputs.
3. *Collective Choice Arrangements*
   Most individuals affected by harvesting and protection rules are included in the group that can modify these rules.
4. *Monitoring*
   Monitors, who actively audit biophysical conditions and user behavior, are at least partially accountable to the users and/or are the users themselves.
5. *Graduated Sanctions*
   Users who violate rules in use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) 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 Organize*
   The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.

For resources that are parts of larger systems:

8. *Nested Enterprises*
   Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Source: Based on Ostrom (1990, 90).

many maps of the reserve, in the relevant national parks, and in many tourist brochures. In a survey of residents of an agricultural community in one of the buffer zones of the reserve, however, Sundberg (1998, 402) found that almost 80 percent of the farmers did not know anything about the reserve or its boundaries (see also the supporting online material for Dietz, Ostrom, and Stern 2003).

PROPORTIONAL EQUIVALENCE BETWEEN BENEFITS AND COSTS

The second design principle is that the rules in use allocate benefits proportional to inputs that are required. If users are going to harvest from a resource over the

long run, they must devise rules related to how much, when, and how different products are to be harvested. They also need to assess the costs on users of operating a system. The design principle related to proportionality of benefits and costs relates to the likelihood that participants will feel that the rules are equitable. If some people pay low costs but get high benefits over time, this inequity frustrates the other participants and may cause more and more to consider the rules unfair and refuse to abide by them. Thus, this design principle is directly related to the attitudes that are necessary to sustain a system over the long run. If some users get all the benefits and pay few of the costs, few of the others are willing to follow rules over time (Ensminger 2000, 2001).

COLLECTIVE CHOICE ARRANGEMENTS

The third design principle is that most of the individuals affected by a resource regime are authorized to participate in making and modifying the rules. Resource regimes that use this principle should be able to craft rules that fit local circumstances and that are considered fair by participants. As environments change over time, officials located far away do not know of the change, so being able to craft local rules is particularly important. Some local common-property institutions empower a local elite to make most of the collective choice decisions. In such cases, one can expect that the policies primarily benefit the elite and are not consistent with the second design principle (for example, see Ensminger 1990; Platteau 2003, 2004).

MONITORING

Few long-surviving resource regimes rely only on levels of trust and reciprocity among appropriators to keep rule-breaking levels down. Evidence of the importance of the fourth design principle—monitoring—has been presented by Gibson, Williams, and Ostrom (2005); Ostrom and Nagendra (2006); Hayes and Ostrom (2005); and Schweik (2000). A recent multivariate analysis by Coleman and Steed (2008) of 130 forests located in a dozen countries found that when local forest users were recognized as having a right of harvesting (having at least the position of authorized user), they were more likely to monitor patterns of harvesting by other appropriators. When this happened, the resource conditions were themselves better than when local users did not monitor each other.

Most institutional analysts have assumed that rules must be enforced in some manner to achieve robust governance, but have not always agreed on who should select the monitors. Most self-organized resource regimes select their own monitors. These monitors are accountable to authorized users and keep an eye on resource conditions as well as on harvesting activities. By creating official positions for local monitors, a resource regime does not rely only on the norms of local right holders to impose personal costs on those who break a rule. In some systems, everyone has a duty to be a monitor, and users rotate into the position. In others, the monitors are paid from funds collected from all authorized appro-

priators. With monitors appointed, those who want to cooperate with the rules so long as others also cooperate are assured that someone is generally checking on the conformance of others. No one likes being a sucker. Thus, participants can continue to cooperate without fearing that others are taking advantage of them.

GRADUATED SANCTIONS

The fifth design principle is the use of graduated sanctions. This finding puzzled me; my 15 years of empirical research on policing in metropolitan areas familiarized me with the literature on the economics of crime that stressed the importance of costly sanctions so that the expected value of breaking a law was higher than the benefit that could be obtained even when the probabilities of being caught were relatively low. In many self-organized systems, the first sanction imposed by a local monitor is so low as to have no impact on the expected benefit-cost ratio of breaking local rules (given the high payoffs that could be achieved by harvesting illegally, for example).

The initial sanction can be thought of more as information to the person who is caught as well as to others in the community. A user might break a rule in error or because of difficult problems. Letting an infraction pass unnoticed could generate a downward cascade of cooperation in a group that relies on conditional cooperation and has no capacity to sanction. When graduated punishments are used, a person who purposely or accidentally breaks a rule is notified that others have noticed the infraction (thereby increasing the individual's confidence that others would also be caught). Further, the individual learns that others basically continue to extend their trust and want only a small token to convey a recognition that the mishap occurred.

HOW DO THESE FIT TOGETHER?

The first five principles fit together to form a coherent theoretical explanation of why they may work together: when the users of a resource design their own rules (design principle 3) that are enforced "by local users or accountable to them (design principle 4) using graduated sanctions (design principle 5) that clearly define who has rights to withdraw from a well-defined resource (design principle 1) and that effectively assign costs proportionate to benefits (design principle 2), collective action and monitoring problems tend to be solved in a reinforcing manner" (Ostrom 2005, 267).

CONFLICT RESOLUTION MECHANISMS

The sixth principle is that there are rapid, low-cost, local arenas in which to resolve conflict among users or between users and officials. Rules have to be understood in order to be effective. Some participants may interpret a rule that they have jointly made in different ways. By devising simple local mechanisms to get conflicts aired immediately and resolutions that are generally known in the community, the number of conflicts that reduce trust can be reduced.

MINIMAL RECOGNITION OF RIGHTS TO ORGANIZE

Whether local users can develop more effective regimes over time is affected by whether a national or local government at least minimally recognizes the right to organize. Participants in resource regimes that are not recognized by external authorities have operated over long periods, but they have had to rely almost entirely on unanimity to change rules (Ghate 2000). Otherwise, disgruntled participants who voted against a rule change can call on the external authorities to threaten the resource regime. Changing rules using unanimity imposes high transaction costs and prevents a group from searching for better-matched rules at relatively lower costs. When external governmental officials presume that only they can make authoritative rules, sustaining a self-organized regime is difficult (Johnson and Libecap 1982).

NESTED ENTERPRISES

When common-pool resources that are being managed by a group are large, an eighth design principle may be present in robust systems. The nested enterprise principle is that governance activities are organized in multiple layers of nested enterprises. In addition to some small units, larger institutions exist to govern the interdependencies among smaller units. The rules allocating water among major branches of an irrigation system, for example, may differ from the rules used to allocate water among farmers along a single distribution channel (Yoder 1994). Consequently, among long-enduring self-governed regimes, smaller-scale organizations tend to be nested in ever-larger organizations.

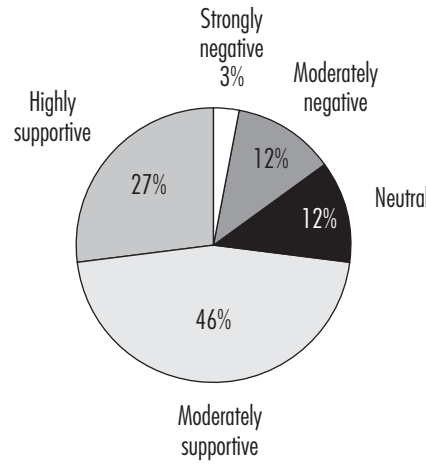
A Current Evaluation of the Validity of the Design Principles

Michael Cox, a graduate student who is studying self-organized irrigation systems in New Mexico (the *acequias* established by migrants from Spain using many of the designs developed in their home country), has coded 33 research papers in which other scholars have evaluated whether the design principles hold up in their studies.[3] Each of the articles looked at one or more resources in some depth and examined which design principles were relevant and were positively related to the outcomes, negatively related, or did not make much difference.

Figure 2.1 presents the distribution across all cases coded with regard to their summary evaluations. It appears that 73 percent of the cases Cox has coded are either moderately or highly supportive of the usefulness of the design principles. Table 2.2 presents the distribution of cases across sectors and across design principles. In general, it looks like the principles are helpful for understanding why some common-property institutions are robust, and it seems that the design principles are themselves relatively robust (only 1 out of 33 studies strongly challenges them).

3. These articles are preceded by asterisks in the reference list.

Figure 2.1
Design Principles Evaluation



SOME GENERAL CONCERNS

While many of the articles were supportive, both general and specific concerns were raised. One had to do with the reliance on a modified rational choice approach. Several publications, including Cleaver (2000), Steins and Edwards (1999a, 1999b), and Young (2002), urged that the reliance on rational choice

Table 2.2
Evaluating the Design Principles

Sector	Forestry	Pastoral Systems	Irrigation Systems	Inshore Fishery	Multiple Resource Sectors	Total
Highly supportive	1		4	1	3	9
Moderately supportive	7	1	4		3	15
Neutral		1	2		1	4
Moderately negative	1	1		1	1	4
Strongly negative					1	1
Total	9	3	10	2	9	33

and collective action needed to be complemented (or perhaps substituted) by a constructivist approach. Steins, Röling, and Edwards (2000, 5), for example, criticized "the conventional scientific belief that reality can be divided into categories, and that its shaping mainly operates through cause-effect relations." I think it is useful to analyze the diverse components of the world we try to analyze. Sometimes those components can be examined using additive models, but I have stressed the importance of understanding how configurations of causal conditions affect incentives, behaviors, and outcomes (see Ostrom 2005, 2007b).

Another general concern was the omission of conditions that enhance the likelihood of crafting a working set of property rights. Scholars have urged the inclusion of such variables as small size, homogeneous groups, and active leadership (Baland and Platteau 1996); dependence on a resource (Gibson 2001); market integration (Tucker 1999; Tucker, Randolph, and Castellanos 2007); external government policies (Rodriguez 2007); and cross-scale linkages (Berkes 2002; Young 2002). All of these and others are important variables, and I used them and other variables in related work to explain the factors affecting the emergence of new institutions (Ostrom 2001). They are among the variables that affect whether resource users will organize to solve the collective action problem of self-organization in the first place. As such, they are causal variables of a process. The design principles, on the other hand, are an effort to understand why the results of this process are robust in some cases and fail in others.

CONCERNS REGARDING SPECIFIC PRINCIPLES

Clearly Defined Boundaries Some scholars suggested dividing the principle of clearly defined boundaries into two parts, one focusing on the boundaries of those authorized to use a common-pool resource and the other related to the boundaries of the resource itself (Agrawal 2002). Specifying these as two principles may help in regard to another concern related to the rigidness of the boundary of a resource. Cleaver (2000) and Turner (1999) suggested that the boundaries of the resource can be fuzzier than the boundaries of who is authorized to use the resource. When two user groups work side by side, they may have backup arrangements that enable them to utilize each other's resource under commonly understood conditions.

One confusion about boundary rules is related to the difference between a careful definition of the boundaries of a resource (and potential of other related resources) and those boundaries being rigid and unchanging. For many pastoral resources, the boundaries of the physical resource may change depending on the season and patterns of rainfall. Most pastoral peoples' resources have several boundaries. One boundary relates to where they live most of the year. A second boundary relates to where they can pasture animals during normal seasons. A third—and possibly a fourth—boundary frequently exists for a backup region that may be available to a well-defined group in seasons when its home territory is facing dire scarcity. When rainfall is abundant, there are few questions about

where to pasture animals. If the rainfall for that area has been scarce, other areas may have more adequate rainfall and forage availability. Most pastoral peoples have secondary and tertiary rights to pasture animals in the other regions depending on the season (Agrawal 1999). Quinn et al. described the problem as now compounded by the central designation of village boundaries:

> Physical boundaries on resources in Africa are often not clearly defined and there are two important facets as to why this is the case. The nature of semi-arid regions means that resource availability varies both spatially and temporally (Cousins 2000). . . . Imposed over this ecological variability in resource availability are the socio-political boundaries created by culture and political administration. For example, the political administration units created by villagisation in Tanzania do not necessarily relate to the underlying ecological boundaries. The tension between political and ecological boundaries creates a situation where the boundaries on resource users are often "fuzzy" as resource users are drawn from a wider community than just one village, and different social and ethnic groups use overlapping parts of the same resource. (2007, 105–106)

Thus, as we move to dividing the first principle into two parts, it is also important to clarify what is meant by clear boundaries. Even when scholars have used fuzzy set theory to define boundaries, the boundaries of each of the resources in a set of resources are relatively clearly defined. It is not reasonable to put up fences to clearly demark all boundaries in large pastoral or forest areas, but most such resources in the field do use some kind of stone or plant species to mark the boundaries on the various paths used frequently.

Niamir-Fuller focused extensively on this first principle from her own research experience on pastoral peoples in Africa. She also described the boundaries among different user groups as fuzzy and containing overlapping zones that "are jointly managed by the neighboring tribes" and buffer zones that "often did not come under strict management by any group, but access to them was negotiated between parties concerned on an ad hoc basis" (1998, 269). Niamir-Fuller pointed out that it is very important to understand that "although different people can use the same communal land, users are subject to regulations that determine their *priority* of use. Any group has priority of use within the boundary of its 'home territory,' but this land can also be used by others seasonally or infrequently" (1998, 272–273).

Morrow and Hull pointed out that many donor projects formally met the first design principle. Formal congruence with the first principle is not enough, however, to enable appropriators to defend their borders from free riders. They suggest rephrasing the first design principle as: "The resource itself and the users of the resources are clearly defined, and the appropriators are able to effectively defend the resource from outsiders" (1996, 1643). Given our own findings about the importance of defending boundaries, this rephrasing is a positive step forward (Gibson, Williams, and Ostrom 2005; Hayes and Ostrom 2005).

Congruence Between Appropriation and Provision and Local Conditions The principle of congruence between appropriation and provision and local conditions should probably also be divided into subtypes: one related to the congruence with the local ecology, and a second related to the congruence between the amount that a user is authorized to harvest and the user's responsibilities for contributing labor or other resources. Some scholars have also identified local conditions as involving the predominant culture, ideology, customs, and livelihood strategies (Gautam and Shivakoti 2005; Hallum 2008; Morrow and Hull 1996; Young 2002). Morrow and Hull restated it as "Appropriation and provision rules are congruent with the resource and with the cultural norms and social and economic patterns of interaction of the appropriators. The pace and scale of the institution are congruent with traditional decision-making processes" (1996, 1643). Thus, this principle may need to have three subparts specifically dealing with congruence with the local ecology, congruence with the local culture, and congruence between benefits and costs.

Collective Choice Arrangements The common choice arrangements principle has been discussed extensively in the common-property literature. Platteau (2003, 2004), for example, indicated that the users of locally controlled resources do not always have the opportunity to make their own rules. Some local resources are dominated by an elite who decide to receive most of the benefits and pay few of the costs. Where this happens, the collective choice arrangements are not consistent with design principle 3.

Several authors identified collective choice arrangements and related principles as helping to explain outcomes achieved in different locations. Gautam and Shivakoti (2005), for example, examined the relevance of collective choice arrangements and other design principles for understanding the difference in outcomes for two forest systems serving users with similar socioeconomic attributes located in one ecological zone of Nepal. In Dhulikhel, the forest is legally a national government forest and formally administered by a local district forest office. Little consensus exists among the users of the Dhulikhel Forest regarding harvesting practices, and no mechanisms exist for the users to express their views about the rules that should be used. In Jyalachitti, the forest was handed over to a formally established forest user group (FUG) in 1992. Since then, the FUG has developed its own rules based on local customs, livelihood strategies, and the socioeconomic context. The rules have been designed to enhance the regrowth of the Jyalachitti Forest, which was severely degraded in the 1960s when it was still a national forest. Gautam and Shivakoti reported considerable regrowth in the Jyalachitti Forest, but indicated that conditions were worsening in the Dhulikhel Forest. The two forests also differed in regard to graduated sanctions and the extent of conflict resolution mechanisms that, together with having their own collective choice arrangements, have enabled the users of the Jyalachitti Forest to achieve considerable improvement as contrasted to the Dhulikhel Forest.

Monitoring and Graduated Sanctions In some cases, there was a little confusion between the process of monitoring and the process of sanctioning. Scholars, such as Wilson (2007), also pointed out the importance of environmental monitoring in complex ecological systems as well as monitoring the behavior of other users. Most of the studies coded in the spring of 2008 agreed with the importance of monitoring and graduated sanctions. Gautam and Shivakoti (2005, 169) recommended an addition to this principle that "there is no external pressure, which can effectively undermine local monitoring efforts" since they observed external processes that undermined effective monitoring and sanctioning in one of the forests they studied. Sarker and Itoh (2001) examined a set of long-enduring Japanese irrigation systems and found that while there were no official rules establishing monitoring arrangements and graduated sanctions, these principles implicitly characterized most of the irrigation systems they studied.

In the Guatemalan community that Hallum analyzed, she found that the users of the resource monitored compliance with harvesting rules using the maps and schedules they developed as they themselves used the forest. She pointed out that "in a close-knit rural community, it is very difficult for anyone to 'get away with' infractions" (2008, 17). If rules were broken, the sanctions tended to range from extra work assignments (in the community tree nursery or transplanting) to a reduction in access for obtaining firewood for infractions that were more serious. If even more serious rules were broken, a special meeting might be called at the local church and the church bell rung to call attendance and attention.

Trawick analyzed a community irrigation system in Peru where the farmers developed a contiguous pattern for irrigating one section of the system at a time before moving to other sections. This system was effective at conserving water, but it also made irrigation a public affair and monitoring much easier:

> Since everyone knows the rules that govern distribution, and thus the exact order in which they are supposed to receive water, and because the owners of adjoining parcels tend to irrigate on the same day, people are normally putting their fields in order, or simply waiting and watching, while their neighbors finish their turns. This means that monitoring, an essential function in any irrigation system, is pervasive and routine, spread out among users throughout the system, rather than a special task put entirely in the hands of the water distributor. The vigilance helps the distributors in ensuring that traditional procedures are followed, and it has the vital effect of providing controls upon theft, favoritism on the part of water officials, and other forms of corruption. (2001, 15)

One of my own vivid recollections from doing fieldwork in the Middle Hills of Nepal during the 1990s was seeing an enclosed field with a domesticated cow in the center of a village. In response to my question about what was happening, my Nepali colleagues indicated that the enclosure was a kind of "cow jail." When three adult members of the local farmer-managed irrigation system agreed

that a member had not followed water harvesting or maintenance rules after receiving a verbal warning, they were authorized to bring a cow from the errant farmer's fields to the village area. In an agricultural village, everyone knows who owns a cow. Thus, while the cow was grazing in the center of the village and producing milk for the village council to distribute, all the farmer's neighbors were learning about the farmer's nonperformance. Once the farmer had paid a modest fee for breaking the rules, the cow would be returned, so this second-stage sanction was not severe in the long run. Needless to say, most members of the irrigation system preferred to follow the rules rather than being embarrassed by this form of a graduated sanction.

Conflict Resolution Mechanisms The need for relatively low-cost, speedy, and effective conflict resolution mechanisms had general support from the authors of the 33 studies. Gautam and Shivakoti described the provisions for conflict resolution in Jyalachitti—their successful case: "The forest users' committee usually resolves smaller internal conflicts, particularly related to the harvest and distribution of forest products. More complicated conflicts internal to the FUG are resolved in FUG assemblies, sometimes with facilitation by local forestry staff. The FUG seeks support from the DFO for resolving conflicts arising from external factors. Being a semiautonomous entity, the FUG has the right to go to court for more serious conflicts, but that has not yet happened" (2005, 165).

The problem of conflict resolution in their second, and less successful, case is more complicated given the substantial differences in views of how the forest should be managed and the fact that "traditional mechanisms for dealing with internal conflicts that worked for centuries have eroded in recent years due to strong political divisions among the users." They concluded that the "institutions governing the Dhulikhel forest system have also failed to provide low-cost, local arenas to resolve conflict" (Gautam and Shivakoti 2005, 165).

Minimal Recognition of the Rights to Organize Considerable evidence exists in the case studies that violations of the principle of minimal recognition of the right to organize have been associated with less successful community-based resource management regimes. Sometimes NGOs that are created to help local groups, as well as government agencies, overlook the authority of locals. Morrow and Hull suggested the following wording: "The rights and ability of appropriators to devise their own institutions are not challenged by any other authorities, internal or external, that have the ability to undermine the institution" (1996, 1651). Gautam and Shivakoti (2005) made a similar recommendation.

Nested Enterprises Scholars focusing on pastoral and irrigation systems stressed the importance of nesting smaller common-property systems in larger and still larger ones, given the high probability of their having cross-scale physical relationships (Lane and Scoones 1993; Niamir-Fuller 1998). Marshall (2008)

described the challenge of applying this principle in designing more effective community-based environmental governance systems in Australia while agreeing with its importance. He stated that the "principle of subsidiarity" is helpful in understanding and applying the concept of nesting (see also McKean 2002). This principle implies "that any particular task should be decentralized to the lowest level of governance with the capacity to conduct it satisfactorily" (Marshall 2008, 80).

Armitage related the principle of nested enterprises to the concept of multilevel systems that is an essential attribute of natural systems analyzed by ecologists related to their resilience. He provided an overview of diverse experiences with linking governance and ecology across scales in Cambodia, Canada, India, Indonesia, and Sweden (2008, 12–13). As have others (myself included), Armitage warned against using design principles as a recipe in a top-down design process, pointing out that:

> Issues of power and control, the social construction of problems, knowledge valuation and the positioning of different groups suggest that adaptive, multi-level governance in specific places and at specific times is dependent on variables and events that require thoughtful deconstruction. . . . Deliberative processes which encourage reflection, observation and opportunities for communication and persuasion among social actors where uncertainties are high (see Stern 2005) will be important in helping to articulate the full range of principles, values, models and assumptions. (2008, 25–26)

Thus, the nesting principle is shown to be important, but without providing a simple formula that can be applied in a routine manner. Authors have stressed the importance of this principle and the multiple ways that it has been interpreted and applied in the field.

Where to from Here?

Scholars have looked critically at the relevance of the design principles and generally agree that they are capturing some important underlying elements in the wide diversity of institutional arrangements of groups that have sustainably used their resources over time. It appears that there are some advantages to rephrasing and expanding some of the design principles, and this will take place after additional articles have been analyzed and entered into the database. The major thrust of the revisions will likely be to clarify them and to add further related attributes.

Another task will be to address the question of whether meeting all the design principles is a necessary—or a necessary and sufficient—condition for robust and sustainable resources and long-lived institutions. Given the complexity of the resources that are included in the broad definition of common-pool resources, it is unlikely that any list of design principles could be both necessary and sufficient

conditions for robustness. A group that designs a property rights system that meets most of the design principles has increased the probability of its surviving many disturbances over time and being robust. Further, if none of the design principles are present, relatively rapid failure can be predicted—as many empirical studies have shown.

Using the Design Principles

There is a danger that project planners searching for the right design will try to build a one-size-fits-all project based on the design principles (Campbell et al. 2006). It is important to match the rules of a system to the underlying biophysical world and type of human community involved. The question is often raised, however, of how the design principles can be used in practice in addition to their use in organizing continuing research.

Michael McGinnis (personal communication) has suggested drawing on the work of Herbert Simon (1972, 1981, 1995, 1999), who stressed the complexity of designing humanly engineered systems, whether they be computers, road networks, or institutional arrangements. My earlier work related to the impossibility of doing a complete analysis of a complex, adaptive system was strongly influenced by Simon's work. Simon pointed out that where one begins a search to improve the importance of a complex system can make a substantial difference in the quality and speed of the search process. Thus, in thinking about the practical implications of the design principles, one approach is to think of them as the starting point for conducting a search of appropriate means of solving problems. The principles can then be translated into a series of questions about improving the robustness of a common-pool resource system, such as this rough translation of the first six design principles:

1. How can we better define the boundaries of this resource and of the individuals who are authorized to use it so as to ensure clarity in who is authorized to harvest and where harvesting is authorized?
2. How can we improve the relationship between the benefits received and the contributions to the necessary costs of sustaining this system?
3. How can we enhance the participation of those involved in making key decisions about this system?
4. Who is monitoring this system, and do they face appropriate incentives given the challenge of monitoring?
5. What are the sanctions we are authorizing, and can they be adjusted so that someone who makes an error or a small rule infraction is warned sufficiently so as to ensure longer-term compliance without having to impose unrealistic sanctions?
6. What local and regional mechanisms exist to resolve conflicts arising over the use of a resource? (Ostrom 2005, 270–271)

Since the seventh and eighth principles relate to higher levels of governance, they could be translated as:

7. Are there functional and creative efforts by local appropriators to create effective stewardship mechanisms for local resources that should be recognized?
8. How do we create a multiple-layer, polycentric system that can be dynamic, adaptive, and effective over time?

Of course, these are not the only questions that local users and officials should ask in trying to implement an effective design process, but given the substantial evidence that the design principles do characterize successful systems, they can be thought of as a good beginning. We all face a long list of questions to be pursued in our future work.

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