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NEITHER MARKET NOR STATE: GOVERNANCE OF COMMON-POOL RESOURCES IN THE TWENTY-FIRST CENTURY

by

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IFPRI Lecture Series

Neither Market Nor State: Governance of Common-Pool Resources in the Twenty-first Century

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Lecture presented June 2, 1994
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Foreword

Property rights and tenure issues are important to assure success in efforts to combine appropriate management of natural resources with productivity increases in developing-country agriculture. Failure to understand existing and alternative property-rights arrangements and how they work may result in inappropriate action by governments and nongovernmental organizations. Research to enhance such understanding is of critical importance and occupies high priority within the current five-year plan of IFPRI.

While much attention is paid to the negative effects of free access to natural resources and the potential benefits from privatization of natural resource ownership, this lecture describes common-property institutions and illustrates how they may be superior to both free access and private ownership to achieve appropriate natural resource management and sustainability in agricultural production. Professor Ostrom demonstrates how well-meaning government action aimed at environmental protection may destroy existing community-level arrangements to the detriment of both natural resources and the people living in the community. Action by governments and nongovernmental organizations should enhance rather than replace social capital, which has been built up at the community level over generations.

Professor Ostrom argues convincingly that local common-property institutions are effective if not essential components of successful future management of natural resources. While some things are best done by governments or the market, others are more appropriately done by community-level institutions, that is, "neither market nor state."

Per Pinstrup-Andersen
Director General

Neither Market Nor State: Governance of Common-Pool Resources in the Twenty-first Century

Elinor Ostrom

The twenty-first century is just around the comer. Will the local, self-organized communities that have governed and managed many natural resource systems continue into the next century? Or will they slowly disappear—relics of a dying past? So many have disintegrated during the past century that some scholars worry that they will all be destroyed.[1] Will all common-property institutions be taken over by states or by markets? Can indigenous resource governance and management regimes really cope with the problems of a modern age? Are these locally developed institutions, which rely on knowledge acquired over time, effective, or does modern science provide better ways of managing local resources?

First, let me clarify some points. Resource systems lacking effective rules regarding access and use patterns are "open-access" resources—rather than resources governed by common property regimes (Ciriacy-Wantrup and Bishop 1975; Bromley et al. 1992). Valuable open-access resources are always subject to overuse and potential destruction. Further, the problem of designing effective rules to govern and manage natural resource systems is difficult no matter what institutional arrangements—simple or complex—are used.

Second, the variety of human and biological adaptations to diverse ecological niches is so great that I am willing to make the following assertion:

> *Any single, comprehensive set of formal laws intended to govern a large expanse of territory and diverse ecological niches is bound to fail in many of the habitats where it is supposed to be applied.*

It is the *match* of institutions to the physical, biological, and cultural environments in which they are located that will enable institutions (and

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[1] See the very interesting articles by Atran (1986; 1993) on common-property institutions that are not likely to survive into the twenty-first century.

the resources to which they relate) to survive into the twenty-first century.

Third, we will all be the poorer if local, self-organized institutions are not a substantial portion of the institutional portfolio of the twenty-first century. Many indigenous institutions developed to govern and manage local common-pool resources have proven themselves capable of enabling individuals to make intensive use of these resources over the long run—centuries or even millennia—without destroying the delicate resource base on which individuals and their future offspring depend for their livelihood (E. Ostrom 1990). Under banners associated with conserving the environment for future generations, international donors, national governments, international nongovernmental organizations, national charities, and others have, in many cases, unwittingly destroyed the very social capital—the shared relationships, norms, knowledge, and understanding—that has been used by resource users to sustain the productivity of natural capital over the ages.

These institutions are most in jeopardy when central government officials presume they do not exist (or are not effective). Thus, in response to the opening questions, my answer is straightforward. If we do not find the means to enhance the capabilities of local, indigenous institutions to govern and manage smaller common-pool resources effectively, the absence of such institutions in the twenty-first century will lead to an even greater acceleration of the destruction of valuable natural resources.

For those who doubt the viability of common-property institutions in a modern age, let me also point out that many such institutions exist and are growing in numerical strength outside the realm of natural resources. The modern corporation is itself a form of common property. Since the foundational work of Ronald Coase (1960), students of industrial organization have asked a question of considerable importance: When will entrepreneurs rely primarily on a series of market transactions to put together the factors of production needed to create a product, and when will they rely on creating a firm where factor owners each have specified rights and duties on a continuing basis (Williamson 1985)? A housing condominium is also a common-property institution. While individual families own the apartments in a "condo," they have joint rights and duties in relationship to the buildings and grounds of their condo. Some of the most imaginative work on enhancing urban neighborhoods relates to helping tenants of public housing projects acquire joint ownership and management of these projects. This is a shift from government ownership to a common-property arrangement.

Let me now provide some definitions, so we can share a common language for analysis. First, let us define common-pool resources. Common-pool resources (CPRs) are natural or human-made facilities (or stocks) that generate flows of usable resource units over time. CPRs share two characteristics: (1) it is costly to develop institutions to exclude potential beneficiaries from them, and (2) the resource units harvested by one individual are not available to others (E. .Ostrom, Gardner, and Walker 1994; Gardner, Ostrom, and Walker 1990). The

first characteristic is held in common with those goods and services referred to as public goods. The second characteristic is held in common with those goods and services referred to as private goods in the economics literature. Given that it is difficult and costly to design institutions that successfully exclude some potential beneficiaries from access to CPRs, many CPRs are in fact open-access resources where anyone who wishes can gain access and appropriate resource units. Given that the resource units appropriated by one user are not available to others, overuse or even destruction of the resource is a frequent consequence of allowing CPRs to be left as open-access resources.

All common-pool resources have both stock and flow aspects. An irrigation system, a grazing area, a mainframe computer, and a bridge are all examples of resource systems, either natural or human-made. Water, fodder, central processing units, and units crossing the bridge are examples of the flow of resource units from such systems. Analysts sometimes confuse opportunities and constraints related to the flow aspects of a CPR with those related to the stock or facility aspects. If the flow units are appropriated and packaged for further use, they may be bought and sold in a market. Simply finding a legal method to achieve the buying and selling of flow units, however, does not solve the problem of enhancing, maintaining, or regulating the facility or stock system. Thus, governance arrangements that have successfully coped with the provision, production, appropriation, and use of CPRs are frequently complex property-rights systems that do not fit easily into neat and fashionable dichotomies. While there may be aspects of these systems that involve sanctions and coercion, they are not state entities. While there may be aspects of these systems that involve buying and selling resource units, they are not market institutions.

In analyzing the types of institutions that will successfully govern and manage common-pool resources in the twenty-first century, let me divide the rest of this lecture into three parts. First, I will look backward and summarize what we have learned from studying enduring institutions that have successfully governed and managed resource systems for very long periods of time, including some that have survived for a thousand years. Second, I will look to the present and summarize what we have learned from comparing the performance of farmer-organized irrigation systems with government-run irrigation systems in Nepal. Third, I will look to the future and address what we need to apply from the past and the present to enhance the future of institutions that effectively govern and manage common-pool resources.

WHAT CAN BE LEARNED FROM LONG-ENDURING CPR INSTITUTIONS?

One research thrust in the study of CPR institutions examines a diversity of field settings in which appropriators (the fishers, water producers, grazers, and forest users) have devised, applied, and monitored their own rules to control the use of CPRs that have survived for long periods of time (E. Ostrom 1990, 1992). The youngest institutions to be included in this analysis—the Philippine *zanjeras*

irrigation systems—are more than 100 years old. The history of the oldest system—the Valencian irrigation system in Spain—exceeds 1,000 years. The history of mountain-grazing institutions in Switzerland extends back to the thirteenth century. The institutions included have survived droughts, floods, wars, pestilence, and major economic and political changes. These institutions are a form of social capital resulting from the time and effort invested by their creators in improving their productivity.

The institutions, of course, have not remained entirely fixed over their lifetimes. All of them are complex and have had to change over time. These institutions are, however "robust" or in "institutional equilibrium" in the sense defined by Shepsle (1989, 143), who regards "an institution as 'essentially' in equilibrium if changes transpired according to an *ex ante* plan (and hence part of the original institution) for institutional change." In these settings, the appropriators (users) designed their own rules, created organizations to undertake the day-to-day management of their resources, and modified their own rules over time in light of past experience.

The specific rules-in-use, however, differ markedly from one case to the next. Given the great variation in rules-in-use, the sustainability of these resources and their institutions cannot be explained by the presence or absence of particular rules. That the rules do differ partly explains the sustainability of these systems. By differing, the rales take into account specific attributes of the physical systems, cultural views of the world, and the economic and political relationships that exist in the setting. Without different rules, appropriators could not take advantage of the positive features of a local CPR or avoid potential pitfalls that could occur in one setting but not in others.

Seven design principles characterize most of the robust CPR institutions. An eighth principle applies to the larger, more complex ones. A design principle is defined as a conception used either consciously or unconsciously by those constituting and reconstituting a continuing association of individuals about a general organizing principle.[2]

1. Clearly Defined Boundaries

Individuals or households with rights to withdraw resource units from the CPR and the boundaries of the CPR itself are clearly defined.

Defining the boundaries of the CPR and of those authorized to use it can be thought of as a "first step" in organizing for collective action. So long as the boundaries of the resource and the definition of the individuals who can use the resource remain uncertain, no one knows what they are managing or for whom. Without defining the boundaries

[2] The next section draws in part on *Governing the Commons* (E. Ostrom 1990, chap. 3).

of the CPR and closing it to "outsiders," local appropriators face the risk that any benefits they produce by their efforts will be reaped by others who do not contribute to these efforts. At the least, those who invest in the CPR may not receive as high a return as they expected. At the worst, the actions of others could destroy the resource itself. Thus, for any appropriators to have a minimal interest in coordinating patterns of appropriation and provision, some appropriators have to be able to exclude others from access and appropriation rights. If there are substantial numbers of potential appropriators and the demand for the resource units is high, the destructive potential of all users freely withdrawing from a CPR could push the rate used by appropriators to discount the future upward toward 100 percent. The higher the discount rate, the more appropriators ignore the destructive consequences of their own actions on the future condition of the CPR.

2, Congruence between Appropriation and Provision Rules and Local Conditions

Appropriation rules restricting time, place, technology, or quantity of resource units are related to local conditions and to provision rules requiring labor, materials, and/or money.

Unless the number of individuals authorized to use a CPR is so small that their harvesting patterns do not adversely affect one another, at least some rules related to how much of, when, and how a product can be harvested are usually designed by those using the resource. Well-tailored appropriation and provision rules help to account for the perseverance of the CPRs themselves. Uniform rules established for an entire nation or large region of a nation do not take into account the specific attributes of a resource that are used in designing rules-in-use in a particular location. It is this fact that led me to assert in the beginning that "any single, comprehensive set of formal laws intended to govern a large expanse of territory and diverse ecological niches is bound to fail in many of the habitats where it is supposed to be applied." In long-surviving irrigation systems, for example, subtly different rules are used in each system (and frequently on each branch of a larger system) for assessing resource input obligations to support maintenance activities, but those who receive the highest proportion of the water tend to pay the highest proportion of the costs (E. Ostrom 1992). No single set of rules defined for all irrigation systems in a region would satisfy the particular problems in managing each of these broadly similar, but distinctly different, systems.

3. Collective-Choice Arrangements

Most individuals affected by operational rules can participate in modifying operational rules.

Participation in crafting rules related to the day-to-day operation of a resource system may be part of an evolutionary process. In other

words, the operational rules may be customary law, or a "legal system in which the community makes law and changes it by changing its practice without help from the legislator" (Allott 1980, v, cited in Fortmann 1990,195). When appropriators change rules somewhat more self-consciously, they may discuss these changes in a local coffee house, tea stall, or beer hall (as local custom dictates), or at an annual meeting of the appropriators where diverse ways to improve their situation are discussed.

CPR institutions that use this principle are better able to tailor rules to local circumstances, since the individuals who directly interact with one another and with the physical world can modify the rules over time to fit them to the specific characteristics of their setting. Appropriators who design CPR institutions that are characterized by the first three principles—clearly defined boundaries, well-fitting rules, and appropriator participation in collective choice—should be able to devise good rules if they keep the costs of changing rules relatively low.

The presence of good rules, however, does not account for why appropriators follow them. Nor does the fact that the appropriators themselves designed and initially agreed to the operational rules adequately explain centuries of compliance by individuals who were not involved in the initial agreement. It is not even an adequate explanation for the continued commitment of those who were part of the initial agreement. Agreeing to follow rules *ex ante* is an easy "commitment" to make. Actually following rules *ex post,* when strong temptations are present, is the significant accomplishment.

The problem of gaining compliance to rules—no matter what their origin—is frequently assumed away by analysts positing all-knowing and all-powerful external authorities that enforce agreements. In many long-enduring CPRs, no external authority has sufficient presence to play any role in the day-to-day enforcement of the rules-in-use. Thus, external enforcement cannot be used to explain high levels of compliance. In all of the long-enduring cases, active investments in monitoring and sanctioning activities are apparent, which leads us to consider the fourth and fifth design principles.

4. Monitoring

Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators and may be the appropriators themselves.

5. Graduated Sanctions

Appropriators who violate operational rules are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other appropriators, from officials accountable to these appropriators, or from both.

In long-enduring institutions, monitoring and sanctioning are undertaken primarily by the participants themselves. The initial sanctions used in these systems are surprisingly low. Even though it is frequently presumed that participants will not spend the time and effort to monitor and sanction each other's performances, substantial evidence shows that they do both in these settings.

To explain the investment in monitoring and sanctioning activities that occurs in these robust, self-governing CPR institutions, Margaret Levi (1988, chap. 3) uses the term "quasi-voluntary compliance" to describe taxpayer behavior in regimes where almost everyone pays taxes. Paying taxes is *voluntary* in the sense that individuals choose to comply in many situations where they are not being directly coerced. On the other hand, it is "quasi-voluntary because the noncompliant are subject to coercion—if they are caught" (Levi 1988, 52). Levi stresses the contingent nature of a commitment to comply with rules that is possible where the same individuals interact with one another over time. Strategic actors are willing to comply with a set of rules, Levi argues, when they perceive (1) that the collective objective is achieved, and (2) that others also comply. In Levi's theory, enforcement is normally provided by an external ruler, but her theory does not preclude other enforcers.

To explain commitment in many of the cases of sustainable, community-governed CPRs, external enforcement is largely irrelevant. External enforcers may not travel to a remote village other than in extremely unusual circumstances. CPR appropriators create their own internal enforcement (1) to deter those who are tempted to break rules, and thereby (2) to assure quasi-voluntary compilers that others also comply. The Chisasibi Cree, for example, have devised a complex set of entry and authority rules related to the fish stocks of James Bay as well as the beaver stock located in their defined hunting territory. Fikret Berkes (1987, 87) describes why these resource systems and the rules used to regulate them have survived and prospered for so long, "Effective social mechanisms ensure adherence to rules which exist by virtue of mutual consent within the community. People who violate these rules suffer not only a loss of favour from the animals (important in the Cree ideology of hunting) but also social disgrace."

The design of the rules-of-use keeps the costs of monitoring relatively low in many long-enduring CPRs. Rotation rules used in irrigation systems and in some inshore fisheries place the two actors most concerned with cheating in direct contact with one another. The irrigator who nears the end of a rotation turn would like to extend the time of his turn (and thus the amount of water obtained). The next irrigator in the rotation system waits nearby for him to finish and would even like to start early. The presence of the first irrigator deters the second from an early start, and the presence of the second irrigator deters the first from a late ending. Monitoring is a by-product of their own strong motivations to use their water rotation turn to the fullest extent. The fishing site rotation system used in Alanya, Turkey, is similar in that cheaters are observed at low cost by those who most want to deter another cheater at that particular time and location (Berkes

1992). Many of the ways that work teams are organized in the Swiss and Japanese mountain commons also make monitoring a natural by-product of using the commons.

The costs and benefits of monitoring a set of rules are not independent of the particular set of rules adopted. Nor are they uniform in all CPR settings. When appropriators design at least some of their own rules, they learn from experience to craft enforceable rather than unenforceable rules. This means paying attention to the costs of monitoring and enforcing as well as to the benefits that those who monitor and enforce the rules obtain. A frequently unrecognized "private" benefit of monitoring in settings where information is costly is obtaining the information necessary to adopt a contingent strategy. If an appropriator who monitors finds someone who has violated a rule, the benefits of this discovery are shared by all who use the CPR, but they also provide the discoverer with information about compliance rates. If the monitor does not find a violator, it has previously been presumed that private costs are involved, with no benefit to the individual or the group.

By monitoring the behavior of others, the appropriator-monitor learns about the level of quasi-voluntary compliance in the CPR. If no one is discovered breaking rules, the appropriator-monitor learns that others comply, and no one is being "taken for a sucker." It is then safe for the appropriator-monitor to continue to follow a strategy of quasi-voluntary compliance. If the appropriator-monitor discovers rule infractions, it is possible to learn about the particular circumstances surrounding the infraction, to participate in deciding the appropriate level of sanctioning, and then to decide about continued compliance or not. If an appropriator-monitor finds an offender who normally follows rules but happens to face a severe problem, the experience confirms what everyone already knows. There will always be times when and places where those who are basically committed to following a set of rules succumb to strong temptations to break them.

A real threat to the continuance of quasi-voluntary compliance can occur, however, if an appropriator-monitor discovers individuals who break the rules repeatedly. If this occurs, one would expect the appropriator-monitor to escalate the sanctions imposed in an effort to halt future rule breaking by such offenders and any others who might follow suit. In any case, the appropriator-monitor has obtained up-to-date information about compliance and sanctioning behavior on which to make future decisions about personal compliance.

Let us also look at the situation through the eyes of someone who breaks the rules and is discovered by a local guard (who will eventually tell everyone) or another appropriator (who also is likely to tell everyone). Being apprehended by a local monitor when the temptation to break the rules becomes too great has three results: (1) it stops the infraction from continuing and may return contraband harvest to other appropriators; (2) it conveys information to the offender that someone else in a similar situation is likely to be caught, thus increasing confidence in the level of quasi-voluntary compliance; and (3) it imposes a punishment, most likely in the form of a fine plus loss of reputation for reliability.

The fourth and fifth design principles—monitoring and graduated sanctions—thus take their place as part of the configuration of principles that work together to enable appropriators to constitute and reconstitute robust CPR institutions. Let me summarize my argument to this point. When CPR appropriators design their own operational rules (design principle 3) to be enforced by individuals who are local appropriators or accountable to them (design principle 4), using graduated sanctions (design principle 5) that define who has the right to withdraw units from the CPR (design principle 1), and that effectively restrict appropriation activities given local conditions (design principle 2), the commitment and monitoring problems are solved in an interrelated manner. Individuals who think a set of rules will be effective in producing higher joint benefits and that monitoring will protect them against being a sucker are willing to make a contingent self-commitment of the following type, "I commit myself to follow the set of rules we have devised in all instances except dire emergencies if the rest of those affected make a similar commitment and act accordingly." Once appropriators have made contingent self-commitments, they are then motivated to monitor other people's behavior, at least from time to time, in order to assure themselves that others are following the rules most of the time. Contingent self-commitment and mutual monitoring reinforce one another, especially in CPRs where rules tend to reduce monitoring costs.

6. Conflict Resolution Mechanisms

Appropriators and their official have rapid access to low-cost, local arenas to resolve conflict among appropriators or between appropriators and officials.

In field settings, applying rules always involves discretion and can frequently lead to conflict. Even such a simple rule as "Each irrigator must send one individual for one day to help clean the irrigation canals before the rainy season begins" can be interpreted quite differently by different individuals. Who is or is not an "individual" according to this rule? Does sending a child below 10 or an adult above 70 to do heavy physical work meet this rule? Is working for four hours or six hours a "day" of work? Does cleaning the canal immediately next to one's own farm qualify for this community obligation? For individuals who are seeking ways to slide past or subvert rules, there are always ways that they can interpret the rule so that they can argue that they have met its requirements while subverting the intent. Even individuals who intend to follow the spirit of a rule can make errors. What happens if someone forgets about a scheduled labor day and does not show up? Or what happens if the only able-bodied worker in a household is sick, or unavoidably in another location?

If individuals are going to follow rules over a long period of time, some mechanism for discussing and resolving what is or is not a rule infraction is quite necessary to the continuance of rule conformance itself. If some individuals are allowed a free ride by sending less valuable workers to a required labor day, others will consider them-

selves to be suckers if they send their strongest workers, who could be producing private goods rather than communal benefits. Over time, only children and old people will be sent to do work that requires strong adults and the system will break down. If individuals who make an honest mistake or face personal problems that prevent them from following a rule cannot find mechanisms to make up for their lack of performance in an acceptable way, rules can be viewed as unfair and conformance rates decline.

While the presence of conflict resolution mechanisms does not guarantee that appropriators are able to maintain enduring institutions, it is difficult to imagine how any complex system of rules could be maintained over time without such mechanisms. In the cases just described, these mechanisms are sometimes quite informal, and those who are selected as leaders are also the basic resolvers of conflict.

7. Minimal Recognition of Rights to Organize

The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

Appropriators frequently devise their own rules without having created formal, governmental jurisdictions for this purpose. At many inshore fisheries, for example, local fishers devise extensive rules defining who can use a fishing ground and what kind of equipment can be used. So long as external governmental officials give at least minimal recognition to the legitimacy of such rules, the fishers themselves may be able to enforce the rules. But if external governmental officials presume that only they have the authority to make rules, then it is difficult for local appropriators to sustain a rule-governed CPR over the long run. At any point when someone wishes to break the rules created by the fishers, they can go to the external government and get local rules overturned.

Audun Sandberg (1993a, 1993b) provides an insightful analysis of what happens when the individuals using common-pool resources for many centuries do not have recognized authority to create their own rules. The formal rules for the northern Norwegian commons were first written as law in the eleventh century and remained unchanged until 1993. Thus they represented "more than 1,000 years of unbroken traditions of oral and codified Common Law" (Sandberg 1993b, 14). The rules, however, specified only generalized rights and did not recognize any local governance responsibilities. Since most commons, especially the northern commons, came to be conceptualized as the king's commons, it was easy to perceive that the king was the only law-giver with the authority to change laws over time. Through a long process that started with the Protestant Reformation and accelerated around 1750, this eventually led to a conception in government that all forests and mountains in northern Norway that are not private property, which in other countries would be considered commons, are considered state property (Sandberg 1993b, 19). The further effort of the state to then ration access to forests, grazing areas, fisheries, and other

common-pool resources to those engaged in full-time specialized employment has had an unintended effect of being disruptive to the mixed economic way of life of many northerners who were part-time farmers, part-time fishers, part-time foresters, and part-time herders. Converting this sustainable way of life into a modern system, including heavy reliance on transfer payments to specialized farming, fishing, and reindeer ranching, was probably not fully expected by anyone. Now, however, the economic and social base has been weakened enough that simply assigning a local authority to make rules related to the use of common-pool resources would probably not be a sufficient way out of a major dilemma.

8. Nested Enterprises

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

In a larger system, it is quite difficult to devise rules that are well matched to all aspects of the provision and appropriation of (hat system at one level of organization. The rules appropriate for allocating water among three major branches of an irrigation system, for example, may not be appropriate for allocating water among farmers along a single distributory channel. Consequently, among long-enduring self-governed CPRs, smaller-scale organizations tend to be nested in ever-larger organizations. It is not at all unusual to find a relatively large, farmer-governed irrigation system, for example, with five layers of organization, each with its own distinct set of rules.

WHAT CAN BE LEARNED FROM THE STUDY OF PRESENTLY EXISTING CPR INSTITUTIONS?

A turning point in the study of common-property institutions and common-pool resources was the establishment of the Panel on Common Property at the National Academy of Sciences (NAS), Washington, D.C., during the 1980s. The initial publication of the summary volume of the NAS panel (National Research Council 1986), the many important books subsequently published,[3] the revision of the NAS volume (Bromley et al. 1992), the influential article by Feeny et al. (1990), and recent important work on property rights (Libecap 1989; Eggertsson 1990; Bromley 1991) have all contributed to a better understanding of how diverse institutions affect the incentives of local resource users and government officials related to the governance and

[3] These include McCay and Acheson 1987; Fortmann and Bruce 1988; Wade 1988; Berkes 1989; Pinkerton 1989; F. Martin 1989, 1992; Sengupta 1991; Tang 1992; Blomquist 1992; E. Ostrom 1992; Thomson 1992; V. Ostrom, Feeny, and Picht 1993; Netting 1993; E. Ostrom, Schroeder, and Wynne 1993; and E. Ostrom, Gardner, and Walker 1994.

management of CPRs. Earlier in-depth studies of the operation and performance of irrigation systems also provided important insights into factors that are associated with successful self-organization and governance and with breakdown and failure (Coward 1979,1980, 1985; Uphoff 1983, 1986a, 1986b, 1986c; Cernea 1985; Siy 1982). These studies illustrate not only the capabilities of indigenous institutions but also their frailty when confronted with extremely rapid and multiple exogenous changes or when national governments do not recognize their existence or both. Social capital, like physical capital, does not generate the same ratio of benefits to costs as change occurs in the surrounding political, economic, and demographic conditions.

The case-study literature has now demonstrated beyond a doubt that it is possible for CPR appropriators to design, operate, monitor, and enforce their own institutional arrangement. But this literature also documents failures. Thus a key question has been how to develop a more cumulative approach to the development of empirically grounded theory related to the effects of diverse governance arrangements on common-pool resources and the viability of these arrangements in different settings, including those involving change. The Institutional Analysis and Development (IAD) framework, which has itself evolved over time, has proven to be an effective theoretical tool in helping to generate not only the design principles discussed earlier, but a series of studies of multiple settings where further theoretical and empirical progress could be made (see Kiser and Ostrom 1982; E. Ostrom 1986; Oakerson 1986;[4] V. Ostrom, Feeny, and Picht 1993; V. Ostrom 1991). The IAD framework is a method for analyzing how the attributes of a physical and biological world interact with those of the general cultural setting and the specific rules-in-use to affect the incentives facing individuals in particular situations and the outcomes likely to result.

Without data collected systematically about each CPR and rigorous statistical analysis, the multiplicity of potential influences makes it impossible to cumulate knowledge beyond what is possible through a close and detailed comparison of 15 or perhaps 20 resource systems. If knowledge about the configural aspects of the physical, cultural, economic, and institutional worlds that affect resource system performance is to move beyond that attained by doing intensive research on a limited number of systems, it is essential to begin to develop databases including a large set of cases.

A key question has been how to obtain data on a large number of common-pool resources and their relevant institutional arrangements. No data set existed that could be used for this purpose, and collecting data from the field is an expensive operation. The task of simultaneously creating an innovative database with extensive coding of institutional arrangements, while undertaking expensive fieldwork in many locations, was not feasible. Hence, our initial efforts to construct a theoretically

[4] Oakerson's version of the framework was used by the NAS panel as the central framework for organizing a series of case studies on different types of CPRs in different regions of the world.

grounded database were combined with an effort to "mine" the extraordinarily rich case-study literature that already existed. We developed a general CPR database that was capable of coding information about irrigation systems, fishery systems, groundwater basins, and to a more limited extent, forests. Then we entered and analyzed information about 50 irrigation systems from throughout the world, about 50 fishery systems, and a handful of forestry cases.[5]

The findings from these studies are consistent with the design principles delineated. CPR institutions with high levels of performance clearly demark who has the right to use the resource; have themselves crafted rules that are considered fair and well-matched to local physical, biological, and cultural circumstances; have invested in monitoring and sanctioning activities; and have found low-cost methods for resolving conflicts. The variety and ingenuity of their indigenous institutional arrangements is remarkable.

One important finding that I will briefly mention is the absence of rules in some sectors that are frequently proposed as "ideal" policy tools. Among inshore fisheries, Schlager (1989) found no case where inshore fishers had developed a rule system based on allocating the quantity of catch rather than on space, technology, or time of harvest. Wilson's models of multispecies fisheries and their potential chaotic behavior explains, to a large extent, why "fishermen have little or no faith in our ability to control the size of (i.e., sustain) natural populations through quantitative adjustments in catch or effort" (Wilson 1993, 7).[6] Wilson and others now make a convincing argument that the scientific foundations for imposing Individual Transferable Quotas (ITQs) on multispecies fisheries are much weaker than has been supposed, and that rules that focus on space, technology, and time of harvest may, in fact, be more appropriate for managing modern fisheries than those based on a quantitative estimate of sustainable yield. Groundwater producers, on the other hand, developed a series of ingenious rules in southern California for allocating water quotas on a

[5] Award-winning dissertations by Tang (1992), Agrawal (1992), and Schlager (1990) were based on analysis of CPR data.

[6] See Wilson et al. (1991) and Wilson and Kleban (1992). Wilson argues that the Maine lobster fisheries have continued to operate effectively over the long run in spite of frequent predictions by resource economists (himself included at an earlier date) and public officials that it is "for all practical purposes, a fishery governed by fishermen. The importance of self-governance is that the very process of governance creates the social conditions under which individuals are assured (to the extent possible) that the rules chosen will accomplish the end for which they were adopted and that there will be rule compliance by their colleagues. Under these circumstances it is possible for an individual to subscribe wholeheartedly to the logic of individual and collective restraint" (Wilson 1993, 7). In a recent paper, Wilson et al. (1994) coded 32 fishing societies and found only one that had imposed a quantity limit upon itself.

transferable basis that have worked effectively for more than four decades (Blomquist 1992).

During several visits to Nepal during 1988 and 1989, Robert Yoder and Prachanda Pradhan of the International Irrigation Management Institute (HMI) gave us access to the extensive descriptive studies that already existed about Nepal's irrigation systems, particularly farmer-managed systems. A repeated and surprising finding from these case studies is that agricultural productivity is higher in many farmer-managed systems than in the larger, professionally managed government systems (Pradhan 1989; Svendsen and Small 1990; Laitos et al. 1986; E. Martin and Yoder 1983; Shivakoti 1991, 1992; Yoder 1986). But, many scholars and officials rejected these findings because they came from only a few isolated case studies. After further collection, we found even more case studies of irrigation systems in Nepal. We now have an archive of descriptions of more than 150 irrigation systems from a variety of sources. Consequently, a specialized database focused entirely on Nepal was created that could then be used for policy purposes as well as for further research and teaching purposes. With a team of colleagues familiar with either Nepal irrigation systems or our IAD framework, we coded these cases using a carefully developed coding form.[7]

We were then confronted with the problem of what to do with data that did not answer some of our most basic questions. On completion of coding and entry of the data, should we proceed with analysis of material that was at best incomplete and at worst, inaccurate? We were able to obtain funding from the Ford Foundation for fieldwork in Nepal to "ground-truth" the coded case materials and do original fieldwork on additional irrigation systems where feasible. Eighty irrigation systems were visited to fill in missing data and to check out the coding that had been done in the original case study.

Our analysis focused initially on 127 systems for which substantial information was available in the original document or was supplemented by site visits (see E. Ostrom, Benjamin, and Shivakoti 1992). The initial analysis, based on this large number of Nepali irrigation systems, confirms the earlier reports by many case study authors that farmer-managed irrigation systems (FMIS) in Nepal perform more effectively in terms of agricultural productivity than agency-managed irrigation systems (AMIS). Yield data exist for 108 of the 127 systems. The 86 FMIS average 6 metric tons a year per hectare; the 22 AMIS average 5 metric tons a year per hectare ($p = .06$).

FMIS also tend to achieve higher crop intensities. A crop intensity of 100 percent means that all land in an irrigation system is put to full use for one season or partial use over multiple seasons, amounting to the same coverage. Similarly, a crop intensity of 200 percent is full use of all land for two seasons; 300 percent is full use for three seasons. The cropping intensity achieved at the head end of AMIS is 208 percent; at the head end of FMIS, 246 percent ($p = .001$). The cropping intensity at the tail end of AMIS is 182 percent; at the tail end of FMIS, it is 237 percent ($p = .001$).

The agricultural yields and crop intensities that farmers obtain depend on whether they can be assured of water during the winter and spring seasons when water becomes progressively more scarce. A higher percentage of FMIS in Nepal are able to get abundant water to *both* the head and the tail of their systems across all three seasons, as shown in Table 1. During the spring, when water is normally very scarce, about 1 out of 4 FMIS are able to get abundant water to the tail of their systems, while only 1 out of 11 AMIS are able to do so. Even in the summer monsoon season, less than half of the AMIS get abundant water to the tails, while almost 90 percent of the FMIS do.

To begin to address why FMIS are more likely than AMIS to distribute water more equitably between head and tail, E. Ostrom and Gardner (1993) analyzed how physical variables and type of governance structure combine to affect the difference in water availability achieved at the head and the tail of irrigation systems. The difference in water availability is a crude indicator of how well an appropriation process gets water to the tail end of a system. We estimated the following equation:

Water Availability Difference = f (Headworks, Lining, Terrain, Length, Labor Input, Type of Governance),

Table 1—Water abundance by type of governance arrangement and season, Nepal

Season of Year	FMIS with Abundant Water at the Head		AMIS with Abundant Water at the Head		FMIS with Abundant Water at the Tail		AMIS with Abundant Water at the Tail	
	(number)	(percent)	(number)	(percent)	(number)	(percent)	(number)	(percent)
Monsoon	100	97	23	91	100	88	23	44
Winter	99	47	23	43	98	38	23	13
Spring	98	34	23	26	96	24	23	9

Source: E. Ostrom and R. Gardner, "Coping with Asymmetries in the Commons: Self-governing Irrigation Systems Can Work," *Journal of Economic Perspectives* 7 (4): 93-112.

Note: FMIS is farmer-managed irrigation systems; AMIS is agency-managed irrigation systems.

[7] It became apparent as we moved through the materials, however, that many answers were missing or that our confidence in their accuracy was low. This was due in part to the quality of some of the materials, but also because we were asking questions that are infrequently recorded by scholars and practitioners interested in irrigation systems. Questions about boundary rules, authority and scope rules, and about sanctioning and monitoring activities were not systematically addressed by prior researchers.

where

Water Availability Difference is the difference in the score (abundant = 2, limited = 1, scarce or nonexistent = 0) achieved at the head of a system minus the score achieved at the tail of a system averaged across three seasons,[8]

Headworks is coded 1 if the headworks are permanent and 0 if otherwise;

Lining is coded 1 if the canals are partly or fully lined and 0 otherwise;

Terrain is coded 1 if the system is located in the Terai (the flatlands of Nepal) and 0 otherwise;

Length is the length in meters of the canals of a system;

Labor Input is the number of labor days devoted to regular maintenance per year divided by the number of households served; and

Type of Governance is coded 1 if an FMIS and 0 otherwise.

The result of a multiple regression analysis for the 76 irrigation systems for which full data is available is

Water Availability Difference = 0.64** + 0.34** Headworks -0.14 Lining - 10* Terrain + 0 Length + 0 Labor Input - 0.32** Type of Governance;

F = 5.92, adjusted R^2 = 0.28, **p < .05, *p < .10.

This analysis illustrates the importance of the physical characteristics of an irrigation system that affect the capacity to distribute the gains from mutual cooperation equitably. The difference in water availability achieved at the head and the tail of these Nepali irrigation systems is significantly and negatively related to being in the Terai. The presence of a permanent headworks—frequently considered one of the hallmarks of a modern, well-operating irrigation system—is positively related to a

[8] Thus, a score of zero indicates that for all three seasons, the level of water adequacy was the same in the head and tail sections of the system. A score of 0.33 indicates that, in one season, the head received adequate water and the tail received limited water or that the head received limited water and the tail received scarce water. For the 118 systems for which we have data, the difference score ranges from -0.66 to 1.66. The regression presented in the text is based on data for 76 systems for which we had data on all variables in the regression equation.

difference between the water availability achieved at the head and the tail. Farmers have little control over the terrain in which their land is located, but farmers and irrigation officials have a good deal of control over other physical attributes such as construction of permanent headworks, lining, or length (the latter two are not associated with water availability differences in this data set). Water availability differences are significantly lower in FMIS than they are in AMIS.

E. Ostrom and Gardner (1993) present a game-theoretic analysis of the bargaining processes between farmers located at the head and the tail of irrigation systems. For systems where the farmers at the head do not need the resource inputs of tailenders (either because nature provided a spring that does not require much maintenance, or because donor funds were used to provide a permanent headworks without cost to be borne by the farmers), the best response of headend farmers is to take all the water they can use (for water-intensive crops or even to suppress weeds) and to ignore the interests of tailenders. Thus, because donors and central governments have concentrated more on the construction of physical capital than on the importance of social capital and the type of design principles discussed earlier, they may have unwittingly increased the power of some farmers over others and helped to destroy social capital without recognizing the consequences of their actions.

This brings us back to the question of whether FMIS in Nepal tend to follow more of the design principles than do AMIS. With regard to the type of monitoring and sanctioning mechanisms used on FMIS as contrasted with AMIS the answer is unambiguous. Lam (1994) has computed an index of institutional development based on monitoring and sanctioning activities. For monitoring, a system received a score of 1 if information was kept about (1) water withdrawal rights, (2) levels of water appropriation, (3) farmer's individual contributions to maintenance, or (4) levels of conformance to the system's rales. For sanctioning, a system received a score of 1 if (5) sanctions varied from low to high or if (6) water withdrawals could be forfeited for some infractions. Thus the index is a seven-point scale that ranges from 0 to 6. Lam used the index to classify irrigation systems into two groups, those scoring at least a 4 on the index and those scoring less than a 4 (Lam 1994, Tables 7.16 and 7.17). Three-quarters of the FMIS scored at least a 4, while only one-quarter of the AMIS had as many monitoring and sanctioning activities (Chi^2 = 11.05, p = 0.00).

Almost all irrigation systems in Nepal have well-demarked boundaries. The difference, however, is the logic used in developing these boundaries. On FMIS, it is the farmers themselves who determine how large an area will be served by an irrigation system. The farmers who then sign a charter or signify in some other way that they will participate in the provision of the irrigation system assume obligations to provide labor and materials for maintenance as well as receiving the benefits of water. Thus, the boundaries of irrigation systems developed by farmers tend to be somewhat conservative, so that those who do put in many days of labor are relatively assured of obtaining water, as the data in Table 1 verifies. On AMIS, boundaries are frequently decided as part of a project planning document, where the incentives for the

engineers relate to showing a positive benefit-cost analysis. As the data in Table 1 illustrate, those located at the tail end of a system do not get water reliably from these systems. Thus, the boundaries may formally include many farmers who cannot rely on the system for regular irrigation other than during the monsoon.

Farmers believe that the rules adopted by FMIS in Nepal equitably distribute benefits and costs compared with AMIS. This is substantiated by the kind of rule-following behavior they exhibit. About half of the FMIS are characterized by high levels of rule-following, whereas only one out of five AMIS systems is so characterized (Table 2). Further, when farmers in FMIS systems do break rules, the level of violation tends to be low in almost 9 out of 10 systems; the AMIS are fairly evenly split between those with low levels of violations and those with medium-to-high levels (Table 3). That conflicts are resolved to a greater extent in FMIS than in AMIS is illustrated by the larger proportion of FMIS farmers who exhibit a high level of mutual trust (Table 4).

WHAT LESSONS CAN WE APPLY FOR THE FUTURE?

Having studied the past and the present, we can now address the lessons we need to apply in the twenty-first century in order to create appropriate institutions for governing and managing common-pool resources. One lesson is that without systematic research over time on the effects of diverse institutions on the incentives and behavior of appropriators and their impact on resource conditions, future public policies may not fully recognize the value of common property institutions. The findings reported here would not have been possible

Table 2—The relationship of rule-following and governance structure

Level of Rule-Following among Appropriators	Farmer-Managed Irrigation Systems		Agency-Managed Irrigation Systems	
	(number)	(percent)	(number)	(percent)
Low-moderate	49	49	17	81
High	52	51	4	19
Total	101	100	21	100

Chi^2 - 7.37
P = .01

Source: W.F. Lam, "A Comparative Study of Farmer-Managed and Agency-Managed Irrigation Systems in Nepal: An Institutional Analysis" (PhD. diss., Indiana University, Bloomington, Ind., U.S.A., 1994).

Table 3—The relationship of the degree of rule-breaking and governance structure

When Rules Are Violated, the Level of the Violation Is:	Farmer-Managed Irrigation Systems		Agency-Managed Irrigation Systems	
	(number)	(percent)	(number)	(percent)
Low	83	87	11	52
Medium-high	12	13	10	48
Total	95	100	21	100

Chi^2 = 13.70
P = 0.00

Source: W.F. Lam, "A Comparative Study of Farmer-Managed and Agency-Managed Irrigation Systems in Nepal: An Institutional Analysis" (PhD. diss., Indiana University, Bloomington, Ind., U.S.A., 1994).

Table 4—The relationship of mutual trust and governance structure

Level of Rule-Following among Appropriators	Farmer-Managed Irrigation Systems		Agency-Managed Irrigation Systems	
	(number)	(percent)	(number)	(percent)
Low	41	41	14	64
High	60	59	8	36
Total	101	100	22	100

Chi^2 = 3.88
P = 0.05

Source: W.F. Lam, "A Comparative Study of Farmer-Managed and Agency-Managed Irrigation Systems in Nepal: An Institutional Analysis" (Ph.D. diss., Indiana University, Bloomington, Ind., U.S.A., 1994).

without a large data set where the effects of multiple variables could be examined simultaneously. We now have a relatively good understanding of the comparative advantages of farmer-managed irrigation systems in Nepal, but much more needs to be learned about irrigation institutions with other kinds of terrain and political regimes. The most pressing need, now that systematic information is available about the impact of irrigation institutions in at least one country, is to obtain reliable and valid information about institutions, incentives, behavior, and outcomes

in other sectors. Given the critical condition of many forests in the world and the relationship between massive deforestation, loss of biodiversity, and global warming, learning more about the uses of common-property institutions related to forests is of prime importance. To improve future policy, we need to understand where and how indigenous forest institutions are most effective and where they are weak. With the appropriate encouragement of local organization of forest user groups, it may not only be possible to reduce risks to the environment but do so in a more cost-effective manner than relying primarily on central direction.[9]

We should not be concerned primarily with the preservation of any one kind of institutional arrangement. Rather, the major problem is to avoid the multiplicity of failed projects and institutions that has dominated past policies. There are obviously many causes of failed projects and institutions. Many are associated with the incentives facing those who design and implement these projects. Few rewards go to those who burden themselves and others with the development of many small projects, or to those who evaluate the benefit side of projects in a conservative manner (Tendler 1975). More fundamental, however, the facilities and resources constructed by a project do not operate or maintain themselves automatically. Human capital and social capital are necessary complementary inputs for physical capital to have a long-standing impact.

All forms of capital are created by spending time and effort in transformation and transaction activities. Physical capital is the stock of material resources that can be used to produce a flow of future income (Lachmann 1978). The origin of physical capital is the process of spending time and other resources constructing tools, plants, facilities, and other material resources that can, in turn, be used in producing other products. Human capital is the acquired knowledge and skills that any single individual brings to productive activity. Human capital is formed consciously through education and training and unconsciously through experience.

Social capital is the shared knowledge, understanding, and patterns of interaction that a group of individuals brings to any productive activity (Coleman 1988; Putnam 1993). Social capital is created when individuals learn to trust one another so that they are able to make credible commitments and rely on generalized forms of reciprocity rather than on narrow sequences of specific quid pro quo relationships. Smith and Jones can accomplish far more per unit of time devoted to

[9] Colleagues in Bolivia, Nepal, and Uganda and at the Workshop in Political Theory and Policy Analysis have just completed the design, pretesting, and piloting of a series of data collection instruments (with contributions by scholars at many institutions throughout the world) to record information about a sample of forests and forest institutions in developing and industrialized countries over time. Readers who would like background information about the International Forestry Resources and Institutions (IFRI) Research Program may write to me or to Mary Beth Wertime, Coordinator, IFRI, at Indiana University, 513 North Park, Bloomington, Indiana 47408-3895.

a joint activity if they do not have to negotiate each and every task in an arm's-length relationship. They can be far more productive with whatever physical and human capital they bring to the joint activity if they can agree on a broad form of coordination and commit themselves credibly to a sequence of future actions (E. Ostrom, Gardner, and Walker 1994). This agreement can be based on mutual learning about how to work better together. It can be based on Smith agreeing to follow Jones's commands (or vice versa) regarding this activity. Or it can be based on the evolution or construction of a set of norms or rules for how this activity will be carried out repeatedly over time and how commitments are monitored and sanctions imposed fornonperformance.

The shared cognitive aspects of social capital help to account for two of its unusual characteristics that differ from those of physical capital. JEijst, social capital does not wear out the more it is used. It may, in fact, improve with use so long as participants continue to keep prior commitments. Using social capital for an initial purpose creates mutual understanding and ways of relating that can frequently be used to accomplish entirely different joint activities at much lower start-up costs. It is not that learning curves for new activities disappear entirely. Rather, one of the steepest sections of a learning curve—learning to make commitments and to trust one another in a joint undertaking—has already been surmounted. A group that has learned to work effectively together in one task can take on other similar tasks at a cost in time and effort that is far less than bringing an entirely new group together who must learn everything from scratch. The fungibility of social capital is, of course, limited to broadly similar activities. No tool is useful for all tasks. Social capital that is well adapted to one broad set of joint activities may not be easily molded to activities that require vastly different patterns of expectation, authority, and distribution of rewards and costs than those used in the initial activities.

jLecQnd,.if unused, social capital deteriorates at a relatively rapid rate. Individuals who do not exercise their own skills can lose human capital relatively rapidly. When several individuals must all remember the same routine in the same manner, however, the probability that at least one of them forgets some aspect increases rapidly over time. Further, as time goes on, some individuals leave and others enter any social group. If newcomers are not introduced to an established pattern of interaction as they enter (through job training, initiation, or any of the myriad of other ways that social capital is passed from one generation to the next), social capital can dissipate through nonuse. Then no one is quite sure how a particular joint activity used to be done. Either the group has to pay some of the start-up costs all over again or forgo the joint advantages that they had achieved at an earlier time.

Thus, a major lesson we need to take forward into the next century is that it is a mistake to design irrigation and other development projects on the presumption that physical capital is the most important input factor in development. What has been overlooked almost entirely (with notable and successful exceptions) is the importance of social capital. When massive amounts of physical capital were introduced by donor countries into the countries of Africa, Asia, and Latin America, that had

been through long periods of colonization, little attention was paid to the massive destruction of social capital that had occurred under colonization. Tribal communities in India, for example, had organized themselves for centuries to derive their food, fodder, tools, and building materials in a sustainable manner from forest lands that they governed and managed as common property. The British government did not recognize community ownership and, in fact, passed legislation during the 1860s to create a forestry department and to exert monopoly power over ever greater territories (Guha 1983). By the time of independence, the government of India exerted full control over more than 40 percent of the total forested area of India. Similar stripping away of the legitimacy of local institutions occurred throughout Africa, Asia, and Latin America.

To the extent that attention was paid to the earlier social capital of the people living in these areas, it was assumed that the former patterns of relationships were "primitive" and not worth saving. Many colonial and postcolonial officials felt that prior institutions had to be destroyed before development could really occur. The diversity of different ways of life was seen as an obstacle to be replaced by modern, centralized institutions that could energize economic activity from the capital.

To integrate what was perceived as overly fragmented ethnic and clan-based political orders, considerable backing was given to regimes that exerted dominance over others. The strong executive, "winner-take-all" form of political order was perceived to be the appropriate way to organize for development. But the leaders of the newly independent countries learned a new form of social capital—how to develop networks of private enrichment from the public treasury; Swiss bank accounts became a major preoccupation of many. (For a discussion of the effects of rent-seeking behavior on development, see Wunsch and Olowu 1990; Sawyer 1992; Bates 1987; North 1990; North and Weingast 1989; and Guyer 1991.) Rent-seeking by national officials continued unabated for many decades because of the scarcity of local institutions that could constrain central governments. Representative bodies have focused more on how to divide the pie than on how to build economies that produce larger pies.

At the macro level, now that the cold war is over, the flow of aid revenue to developing countries will no longer be so large and based on their strategic position in a bipolar world order. The beginning of the twenty-first century will be a painful and dangerous time for developing countries as they face the necessity of holding their own officials accountable. Structural adjustment will come from endogenous processes of developing shared understanding about the importance of limiting the power of central governments.

At the micro level, there are many lessons for the future about how to facilitate the growth of forms of local social capital that will enhance long-term development. Let me briefly describe one development project that has successfully built local social capital and has made a positive impact on the performance of agricultural systems. This is a project funded by the Ford Foundation and designed by the Water and

Energy Commission/Secretariat, Nepal, and the International Irrigation Management Institute in Nepal (WECS/IIMI).

Because of the long-standing research and action program of Yoder (1986) and Pradhan (1988) in Nepal, they knew about a large number of highly successful farmer-governed irrigation systems (as discussed earlier). Because of poor roads and communication networks, however, farmers in one area were unaware of what farmers in other areas were doing. Fanners in many areas could effectively utilize modest levels of new physical capital.

Under the WECS/IIMI project, the capabilities and limits of a large number of farmer-organized irrigation systems in the Indrawati Basin in the Sindhu Palchok District of Nepal were rapidly appraised. More than 20 irrigation systems were identified that could, at least at some level, substantially benefit from better alignment of canals, new materials for aqueducts, and modest lining of the canals. To obtain external aid, the fanners had to agree to several conditions. The farmers would

- cooperate with the engineers sent to help them by showing them how their systems currently operated and where the farmers would like to see improvements,
- contribute most of the labor needed for new construction,
- pay back a modest loan covering a portion of the cost of materials and engineering services over a reasonable period of time,
- agree to go through a training program that would help them enhance their own farmers' organizations, and
- keep records of their expenditures and of decisions made at meetings that were to be available to anyone who asked to see them.

The project hired engineers who would listen to farmers and stress improvements that the farmers themselves could operate and maintain and that would make a big difference in the operation of the system. The designs were shown to the farmers who made suggestions for improvements on a first-, second-, and third-level priority basis, according to how they perceived their importance. The farmers were told that funds would certainly be provided to do the first-priority improvements. If the farmers helped sufficiently in the construction phase, funds would be stretched to cover as many second- and third-priority improvements as possible. (Many of the systems were able to construct all of the desired improvements because of the resources that the farmers themselves contributed.) Since the farmers had to sign off on the designs, a considerable amount of time and effort was put into learning from the farmers about how these systems operated, thus blending the knowledge brought by the design engineers with the local knowledge of the farmers.

The training program was among the more ingenious aspects of this project. It involved farmer-to-farmer training in institutional design. Farmer representatives were taken from the project area to irrigation systems in other districts (similar in terrain) where farmers had designed particularly effective governance structures. The farmer representatives attended an annual meeting of one of these systems; toured the entire

length of the farmer-governed system, discussing with the farmers why they had used different kinds of division mechanisms and how these were related to water rights; and participated in a special session where they could ask the local farmers many questions about the patterns of association that had evolved in the successful systems. In other words, the program enabled farmers who had developed successful social capital in one setting to impart that knowledge to other farmers from a similar setting. Given that the farmers could tell relatively rapidly that the farmers in the systems they were visiting were doing much better than they were, the visiting farmer representative took this training program very seriously. These were not textbook lessons from outsiders: this was a group of similarly situated farmers telling them how to successfully achieve collective action through their own investment in rules tested in local circumstances.

The proof of the effectiveness of this development project is in two forms (WECS/IIMI 1990): the enhanced social capital that resulted from it and the enhanced agricultural product that was achieved. The farmer associations in the project area have all begun the task of developing their own rules based on the general principles they learned from the systems they visited, rather than attempting to copy the particular set of rules they were told about. The WECS/IIMI project has encouraged slow development of rules rather than rapid passage of rules that will not work. Farmers have also learned how to enforce their own rules. Several of the project-assisted systems have branched into new agricultural products that they could not have grown before because their irrigation systems were so unpredictable.

Still more social capital is being formed as a long-run result of these efforts. Some of the farmers from the more successful systems have set up a consulting firm and are running a limited number of training sessions each year. The Rural Resources Center at the Institute of Agricultural and Animal Sciences is now developing an Association of Farmer-Governed Irrigation Systems, which is publishing a Nepali language newsletter that highlights developments of interest to self-organized farmers and describes successful efforts made by existing farmer-governed associations.

The words "social capital" were never used in any of the project documents or in the current plans of colleagues associated with the Institute of Agricultural and Animal Sciences in Nepal. Nor would I want the terms to be officially used in development planning. The routinized use of any term can undermine the process it is intended to facilitate. A project that helps to encourage the development of social capital has built into it from the beginning a respect for the capabilities of farmers. One needs to presume that farmers or other resource appropriators who are successful have something important to share with others, and that those who have not yet figured out effective institutions can do so on their own after exposure to successful and relevant examples (Yoder 1994). Rules and technology can work together to make irrigation systems or other resource systems more effective when those affected have a greater say about the rules and the technology to be used.

Thus a recognition that no one in a nation's capital can develop the full array of social capital needed to govern and manage common-pool resources efficiently and sustainably is a major lesson that academics, donors, international nongovernmental organizations, central governments, and local citizens need to learn and relearn over the coming decades. Enhancing the capabilities of those who are directly concerned with the particulars of a local situation to organize themselves in enterprises that may be deeply nested—to take care of externalities—is a potentially more successful strategy than proposing idealized institutional arrangements that are considered the optimal way of solving resource problems. Common-property institutions are not a relic of the past. They will be a part of the future portfolio of institutional arrangements used in the governance and management of common-pool resources. The more we learn about them in a systematic manner over time, the more likely it is that future policymaking will build more effectively on the strengths of these forms of institutions and avoid some of the errors of the past.

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