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The Governance Challenge: Matching Institutions to the Structure of Social-Ecological Systems

by

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Glossary:

Common-pool resource—a resource system where it is costly to exclude potential beneficiaries, but one person's use subtracts resource units from those available to others.

Governance—the process of crafting institutional rules to fit diverse settings.

Institutional rules— rules defining rights and responsibilities of participants in a repeated setting.

Polycentric systems—a governance system where citizens are able to organize multiple governing authorities at differing scales.

Social-ecological system—an ecological system and a linked social system of resource users and their governance arrangements (if present).

1. The Diversity of Social-Ecological Systems

Readers of this *Princeton Guide to Ecology* will be well informed about the immense diversity of ecological systems. Ecological systems vary in regard to their geographic range, density of specific plant and animal populations, patterns of species diversity, nutrient cycling, landscape dynamics, and disturbance patterns—to name just a few of the subjects included in the Sections of this Guide. Ecological systems are complex systems with interactions occurring at multiple spatial and temporal scales.

In addition to the diversity of ecological systems considered independent of human interactions, the variety of linked social-ecological systems (SESs) that exist in the world is even larger. The "social" side varies in regard to the size and socioeconomic attributes of users, the history of their use, the location of their residences and their work places, the types of leadership and entrepreneurship experienced, the cultural norms they share, the level of human and social capital they have, their knowledge about the ecological system, their dependence on the system for diverse purposes, and the technologies available to them—to name just a few of the most important general characteristics.

Governance is a multilevel process established by humans to craft institutions—rules—that affect who can do what in relation to specific aspects of a linked SES, who will monitor conformance to these rules, and how these rules may be modified over time in light of feedback from the ecological system itself and from those involved in its use, management, and conservation. Governance processes may be undertaken by governments (which are one type of organization) as well as by organizations of all types. Relevant organizations include families, private for-profit and not-for-profit firms, neighborhood groups, and communities living in or near to an ecological system. The rules crafted in a governance process regulate one or more of the following:

- who is authorized to harvest specific types of resource units from a particular SES and for what mix of purposes;
- the timing, quantity, location, and technology of harvesting;
- who is obligated to contribute funds, labor, and other resources to provide infrastructure for or to maintain key attributes of an ecological system;
- how harvesting and contribution activities are to be monitored and enforced;
- how conflicts over harvesting and contributions are to be resolved; and
- how the rules affecting the above may be changed over time with changes in the performance of the resource system and the strategies of participants.

While some policy advocates recommend using one type of institution—such as the creation of private property or the establishment of ownership by a national government—for all ecological systems, considerable evidence exists that all types of institutions fail under some circumstances and succeed under others. The challenge facing those who are involved in the governance of SESs or study governance processes is matching institutional arrangements to the structure of a focal SES and other linked SESs at larger or smaller scales. Since the structure of a SES changes over time, it is also important to enable institutional rules to adapt over time.

2. Common-Pool Resources

Most ecological systems used by multiple individuals can be classified as common-pool resources. Common-pool resources generate finite quantities of resource units. One person's harvesting of resource units from a common-pool resource subtracts from the quantity of resource units available to others. Examples of common-pool resources include both natural and human-made systems including: groundwater basins, forests, grazing lands, fisheries, and irrigation systems. Examples of the resource units derived from common-pool resources include water, timber, fodder, and fish. Most common-pool resources are sufficiently large that multiple actors can simultaneously use the resource system and efforts to exclude potential beneficiaries are costly.

When resource units are highly valued and many actors benefit from harvesting them for consumption, exchange, or as a factor in a production process, the harvests made by one individual are likely to create negative externalities for others. Nonrenewable resources, such as oil, may be withdrawn in an uncoordinated race that reduces the quantity of the resource units that can be withdrawn and greatly increases the cost of harvesting and use. Renewable resources, such as fisheries, may be congested in a particular time period, but may also be so overharvested that the stock generating a flow of resource units is destroyed. An *open-access* common-pool resource (meaning one for which there are *no* rules related to the use of the resource) that generates highly valued resource units is likely to be overharvested and may even be destroyed.

3. The Conventional Theory of Common-Pool Resources

Many textbooks in resource economics and in law and economics present a conventional view of a simple open-access common-pool resource as the only theory needed for understanding how to design better governance systems. In this theory, the users are presented as being trapped in a "tragedy of the commons" and unable to extract themselves from the processes of overuse and potential destruction of the system. The users face a "social dilemma" in that they would all be better off if they all found a way of cooperating together but no one acting alone has an incentive to bear the costs of such cooperation.

Empirical examples exist where the absence of any property rights and the independence of actors capture the essence of the problem facing harvesters. For many scholars, the collapse of many ocean fisheries confirms the worst predictions to be derived from this theory. Since users are viewed as being trapped in these dilemmas, repeated recommendations have been made that external authorities *impose* institutions on such settings. Some recommend private property as the most efficient form of ownership while others recommend government ownership and control. Implicitly, theorists assume that government officials will act in the public interest and understand how ecological systems work and how to change institutions so as to induce socially optimal behavior.

The possibility that the users themselves would find ways to organize themselves is not seriously considered in some of the public policy literature. Organizing so as to create rules that specify rights and duties of participants creates a public good for those involved. Anyone who is included in the community of users benefits from this public good, whether they contribute or not. Thus, getting “out of the trap” is itself a second-level dilemma. Further, investing in monitoring and sanctioning activities so as to increase the likelihood that participants follow the agreements they have made, also generates a public good. Thus, investing in monitoring and sanctioning is a third-level dilemma.

Much of the initial problem is thought to exist because the individuals are stuck in a social dilemma. It is not consistent with the conventional theory that the “helpless” participants solve a second- and third-level dilemma in order to address the first-level dilemma under analysis. Growing evidence from many studies of common-pool resources in the field, however, has called for a serious rethinking of the theoretical foundations for the analysis of common-pool resources. Empirical studies do not challenge the empirical validity of the conventional theory *where it is relevant*, but rather its generalizability to *all* common-pool resources.

4. Self-Organized Resource Governance Systems in the Field

Most common-pool resources are more complex than the base theory of homogeneous users taking one type of resource unit from a resource system that generates a predictable flow of units. A rich case-study literature illustrates the wide diversity of settings in which users dependent upon common-pool resources have organized themselves to achieve much higher outcomes than is predicted by the conventional theory.

Evidence from field research challenges the universal generalizability of the conventional theory. While the conventional theory is generally successful in predicting outcomes in settings where large numbers of resource users have no links to one another and cannot communicate effectively, it does not provide an explanation for settings where users are able to create and sustain agreements to avoid serious problems of overappropriation. Nor does it predict well when government ownership will perform appropriately or how privatization will improve outcomes.

5. Attributes of a Resource and Resource Users that Increase the Likelihood of Self-Organization

Scholars familiar with the results of field research substantially agree on a set of variables that enhances the likelihood of users organizing themselves to avoid the social losses associated with open-access common-pool resources. Considerable consensus exists that the following attributes of resources and of resource users increase the likelihood that self-governing organizations will form and try to increase the probability of a sustainable common-pool resource.

Attributes of the Resource System:

RS1. Feasible improvement: Resource conditions are not at a point of deterioration such that it is useless to organize or so underutilized that little advantage results from organizing.

RS2. Indicators: Reliable and valid indicators of the condition of the resource system are frequently available at a relatively low cost.

RS3. Predictability: The flow of resource units is relatively predictable.

RS4. Spatial extent: The resource system is sufficiently small, given the transportation and communication technology in use, that those users can develop accurate knowledge of external boundaries and internal microenvironments.

Attributes of the Resource Users:

RU1. Salience: Resource users are dependent on the resource system for a major portion of their livelihood.

RU2. Common understanding: Resource users have developed over time a shared image of how the resource system operates (attributes RS1, 2, 3, and 4 above) and how their actions affect each other and the resource system.

RU3. Low discount rate: Resource users do not heavily discount benefits to be achieved from the resource in the future time periods as contrasted to the present.

RU4. Trust and reciprocity: Resource users trust one another to keep promises and relate to one another with reciprocity.

RU5. Autonomy: Resource users are able to determine access and harvesting rules without external authorities countermanding them.

RU6. Prior organizational experience and local leadership: Resource users have learned at least minimal skills of organization and leadership through participation in other local associations or learning about ways that neighboring groups have organized.

When a group of resource users shares these attributes about the resource system and about themselves, they are more likely to agree that all would be better off if they could develop and generally abide by a set of institutional rules for governing their common-pool resource.

6. Types of Ownership Used in Self-Organized Field Settings

The rules adopted by the users of a common-pool resource may approximate private property in some settings. When resource users develop private property rights (utilizing some legal mechanisms available to them via a court system or administrative law), the flows of resource units can usually be measured accurately. This is needed in order to achieve a record of the volume of resource flows (acre-feet of water, board-feet of timber, or tons of fish) that the private right conveys to the owner. Other self-organized institutional rules may define a group as the common owner of a resource and develop specific rules for when and by whom harvesting may be undertaken. Limits may exist on the harvesting technology to be used or the purpose of harvesting (for family consumption and/or commercial purposes) and the responsibilities that co-owners have for maintenance or monitoring. When governments declare ownership of common-pool resources, rules related to who can use and for what purpose are defined and monitored by an administrative agency of the governmental owner.

There are many well-documented examples of private property, community property, and government property systems that work effectively over time to keep the common-pool resource sustainable. Unfortunately, there are also a multitude of empirical examples where private, community, or government ownership are faltering or have collapsed. There are other examples where resource users have not succeeded in overcoming common-pool dilemmas—usually when the resource system is very large.

7. The Importance of Larger Governance Regimes

Many of the variables listed above—particularly those related to the resource users—are strongly affected by the larger political regime in which users are embedded. Larger regimes can facilitate local self-organization by providing accurate information about natural resource systems, providing arenas in which participants can engage in discovery and conflict-resolution processes, and providing mechanisms to back up local monitoring and sanctioning efforts. Perceived benefits of organizing are greater when users have accurate information about the resource itself, about the users of it, and about the threats facing a resource.

The costs of monitoring and sanctioning those who do not conform to rules devised by users are very high, if the authority to make and enforce these rules is not recognized by higher governmental authority. Thus, the probability of users adapting more effective rules when they live in a governmental regime that facilitates their efforts over time is higher than when living in regimes that ignore resource problems entirely or, at the other extreme, presume that all decisions about governance and management need to be made by central authorities. If local authorities are not recognized by larger regimes, it is difficult for users to establish an enforceable set of rules. On the other hand, if rules are imposed by outsiders without consulting local participants in their design, local users may not consider such rules to be legitimate and may try to evade them.

The search for rules that improve the outcomes obtained in commons dilemmas is an incredibly complex task whether undertaken by users or by government officials. It involves a potentially infinite combination of specific rules that could be adopted in any effort to match the rules to the attributes of the resource system. Instead of assuming that designing rules that improve performance of common-pool resources is a relatively simple analytical task that can be undertaken by distant, objective analysts, we need to understand the institutional design process as involving an effort to tinker with a large number of component parts. Those who tinker with any tools—including rules—try to find combinations that work together more effectively than other combinations. Policy changes are experiments based on more or less informed expectations about potential outcomes and the distribution of these outcomes for participants across time and space. Whenever individuals agree to add a rule, change a rule, or copy another successful system's rule set, they are conducting a policy experiment. Further, the complexity of the ever-changing biophysical world combined with the complexity of rule systems means that any proposed rule change faces a nontrivial probability of error.

Policymakers working in a *single* authority for a large region have to experiment simultaneously with *all* of the common-pool resources within their jurisdiction. And, once a change has been made and implemented, further changes will not be made rapidly. The process of experimentation will usually be slow, and information about results may be contradictory and difficult to interpret. Thus, an experiment that is based on erroneous data about one key structural variable or one false assumption about how actors will react, can lead to a very large disaster. In any design process where there is substantial probability of error, having redundant teams of designers has repeatedly been shown to have considerable advantage.

8. The Advantages of Polycentric Resource Governance Systems

Thus, we need to address why a series of nested but relatively autonomous, self-organized, resource governance systems can do a better job in policy experimentation than a single central authority. A polycentric system is one where citizens are able to organize not just one but multiple governing authorities at differing scales. Thus, a polycentric system would have some units at a smaller scale corresponding to the size of the basic common-pool resources in the system. Among the advantages of authorizing the users of smaller-scale common-pool resources to adopt policies regulating the use of common-pool resources are:

- Local knowledge. Resource users who have lived near and harvested from a resource system over a long period of time develop relatively accurate mental models of how the biophysical system itself operates, since the very success of their efforts depends on such knowledge. They also know others living in the area and what norms of behavior are considered appropriate in what circumstances.
- Inclusion of trustworthy participants. Local resource users can devise rules that increase the probability that others will be trustworthy and use reciprocity. This lowers the cost of relying entirely on formal sanctions and paying for extensive guarding.
- Reliance on disaggregated knowledge. Feedback about how the resource system responds to changes in actions of resource users is provided in a disaggregated way. Fishers are aware, for example, if the size and species distribution of their own catch is changing over time and tend to discuss the

size of their catch with other fishers. Irrigators learn whether a particular rotation system allows most farmers to grow the crops they most prefer by examining the resulting productivity of specific fields or talking with others about yields at a weekly market.

- Better-adapted rules. Given the above, resource users are more likely to craft rules that are better adapted to each of the local common-pool resources than any general system of rules.
- Lower enforcement costs. Since local resource users have to bear the cost of monitoring, they are likely to craft rules that make infractions obvious to other users so that monitoring costs are lower. Further, by creating rules that are seen as legitimate, rule conformance will tend to be higher.
- Redundancy. The probability of failure throughout a large region is greatly reduced by the establishment of parallel systems of rule making, interpretation, and enforcement.

There are, of course, limits to all ways of organizing the governance of common-pool resources. Among the limits of a highly decentralized system are:

- Some resource users will not organize. While the evidence from the field is that many local resource users do invest considerable time and energy into their own regulatory efforts, other groups do not do so. Many reasons exist for why some groups do not organize, including the presence of low-cost alternative sources of income and thus a reduced dependency on the resource, considerable conflict among resource users along multiple dimensions, lack of leadership, and fear of having their efforts overturned by outside authorities.

- Some self-organized efforts fail. Given the complexity of the task involved in designing rules, some groups will select combinations of rules that generate failure instead of success. They may be unable to adapt rapidly enough to avoid the collapse of a resource system.
- Local tyrannies. Not all self-organized resource governance systems will be organized democratically or rely on the input of most resource users. Some will be dominated by a local leader or a power elite who only change rules that they think will advantage them still further. This problem is accentuated in locations where the cost of exit is particularly high and reduced where resource users can leave when local decision makers are not responsible to a wide set of interests.
- Stagnation. Where local common-pool resources are characterized by considerable variance, experimentation can produce severe and unexpected results leading resource users to cling to systems that have worked relatively well in the past and stop innovating long before they have developed rules likely to lead to better outcomes.
- Limited access to scientific information. While time and place information may be extensively developed and used, local groups may not have access to scientific knowledge concerning the type of resource system involved.
- Conflict among resource users. Without access to an external set of conflict-resolution mechanisms, conflict within and across common-pool resource systems can escalate and provoke physical violence. Two or more groups

may claim the same territory and may continue to make raids on one another over a very long period of time.

- Inappropriate discrimination. Determining who has a right to use a resource based on ascribed characteristics can be the basis of excluding some individuals from access to sources of productive endeavor that has nothing to do with their trustworthiness.
- Inability to cope with larger-scale common-pool resources. Without access to some larger-scale jurisdiction, local users may have substantial difficulties regulating only a part of a larger-scale common-pool resource. They may not be able to exclude others who refused to abide by the rules that a local group would prefer to use. Given this, local users have no incentives to restrict their own use and watch others take away all of the valued resource units that they have not harvested.

Many of the capabilities of a parallel adaptive system exist in a polycentric governance system. Each unit may exercise considerable independence to make and enforce rules within a circumscribed scope of authority for a specified geographical area. In a polycentric system, some units are general-purpose governments while others may be highly specialized. Self-organized resource governance systems, in such a system, may be special districts, private associations, or parts of a local government. These can be nested in several levels of general-purpose governments that also provide civil, equity, as well as criminal courts.

In a polycentric system, the users of each common-pool resource would have authority to make at least some of the rules related to how that particular resource will be utilized, and thus would achieve most of the advantages of utilizing local knowledge, and the redundancy and rapidity of a trial-and-error learning process. On the other hand, problems associated with local tyrannies and inappropriate discrimination can be addressed in larger, general-purpose governmental units that are responsible for protecting the rights of all citizens and for the oversight of appropriate exercises of authority within smaller units of government. It is also possible to make a more effective blend of scientific information with local knowledge where major universities and research stations are located in larger units but have a responsibility to relate recent scientific findings to multiple smaller units within their region. Because polycentric systems have overlapping units, information about what has worked well in one setting can be transmitted to others who may try it out in their settings. Associations of local, resource governance units can be encouraged to speed up the exchange of information about relevant local conditions and about policy experiments that have proved particularly successful. And, when small systems fail, larger systems can be called upon—and vice versa.

Polycentric systems are themselves complex, adaptive systems without one central authority always dominating all of the others. No guarantee exists that such systems will find an effective combination of rules at diverse levels that are sustainable in any particular environment. In fact, scholars and policymakers should not expect that any governance system will operate over time at optimal levels given the immense difficulty of fine-tuning complex, multitiered systems. Experimentation, feedback, and adaptation is a continuing process required of any governance system for a social-ecological system to be sustainable over time.

Further Readings

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