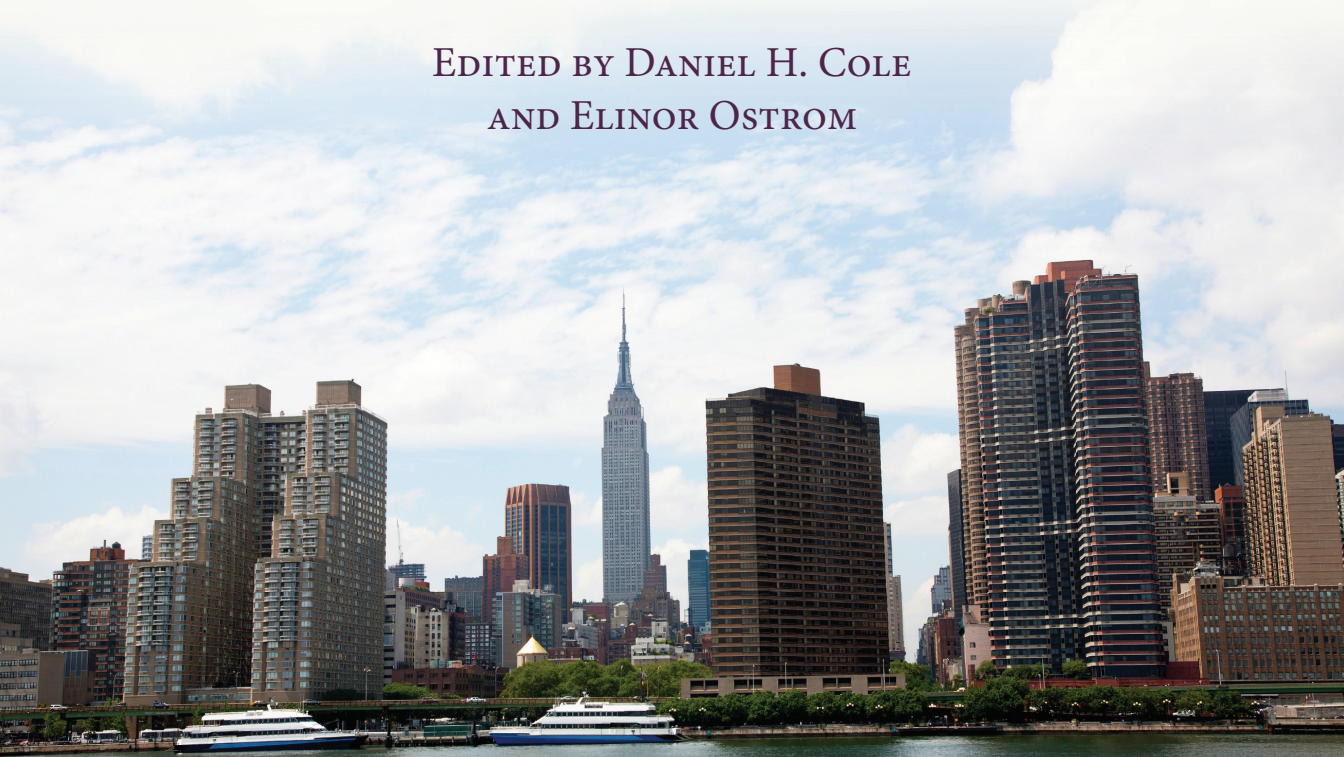
Property in Land and Other Resources

Edited by Daniel H. Cole
and Elinor Ostrom



Foreword by Douglass C. North

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OF LAND POLICY
CAMBRIDGE, MASSACHUSETTS

Library of Congress Cataloging-in-Publication Data

Property in land and other resources / edited by Daniel H. Cole and Elinor Ostrom.
p. cm.
Includes index.
ISBN 978-1-55844-221-4
1. Right of property. 2. Real property. 3. Natural resources. I. Cole, Daniel H. II. Ostrom, Elinor.
HB701.P737 2012
333.3—dc23 2011029993

Designed by Westchester Book Services

Composed in Minion Pro by Westchester Book Services in Danbury, Connecticut.
Printed and bound by Puritan Press Inc., in Hollis, New Hampshire.

♻ The paper is Rolland Enviro100, an acid-free, 100 percent PCW recycled sheet.

MANUFACTURED IN THE UNITED STATES OF AMERICA

Contents

Wildlife

Land and Water

Global Commons Issues

2

The Variety of Property Systems and Rights in Natural Resources

DANIEL H. COLE AND ELINOR OSTROM

Property theory has not kept pace with the growth of empirical and historical data on property systems. Economists, legal scholars, and other social scientists continue to rely on simplistic, outmoded, and incomplete models that fail to capture the variety and complexity of property arrangements found throughout the world. Although one cannot deny the significance and continuing relevance of theories derived from Aristotle, Roman law, and more recent scholarly contributions from the likes of Garrett Hardin and Harold Demsetz, the time has come to move beyond simple models of property panaceas to develop a more descriptively accurate and analytically useful theory of property systems and rights in natural resources.

In 1968 Garrett Hardin used the memorable phrase "tragedy of the commons" to describe a phenomenon that fisheries economists had previously analyzed: natural resources not subject to institutional limitations on access and use would be overexploited, degraded, and eventually destroyed (Gordon 1954; Scott 1955; Warming 1911). The "commons" to which Hardin referred were open-access, common-pool resources where property rights had not been defined. The "tragedy" he described was the inexorable overexploitation and destruction of those resources resulting from the structure of incentives in which no one could exclude anyone else from accessing and using the resource (Hardin 1968).

A year before Hardin published "The Tragedy of the Commons," the economist Harold Demsetz (1967) published an almost equally famous article, "Toward a Theory of Property Rights," which sought to explain the rise of private-individual property rights as a natural, evolutionary response to increasing demand for scarce natural resources.[1] Demsetz's article gave rise to what Eggertsson (1990, 254) has called "the naïve theory of property rights," according to which the entire history of civilization is an inexorable, unidirectional movement toward private-individual ownership of land and other natural resources. In a kind of institution-free, Hayekian spontaneous generation, private-individual property is said to emerge at some point

[1] Demsetz (1967) differed from Hardin (1968) in one very important respect. Hardin was clearly describing a nonproperty/open-access system (a pasture open to all). Demsetz, by contrast, purported to describe an evolutionary shift from common property to private-individual property. His understanding of the common property regime he was purporting to describe was both anthropologically and theoretically flawed.

in the socioeconomic development of every culture in order to reduce externalities and transaction costs as demand for natural resources increases relative to supply. It is also said to increase gains from trade and to facilitate resource conservation (Demsetz 1967; Umbeck 1981).

As Eggertsson suggests, this theory is naïve because (1) it is oblivious to the failure of some private ownership regimes to conserve scarce resources over time (Clark 1973a; 1973b; Hurst 1984); (2) it neglects the effectiveness of alternative property/regulatory arrangements that have evolved to manage scarce natural resources successfully throughout the world (E. Ostrom 1990; Poteete, Janssen, and Ostrom 2010); and (3) it implausibly promotes private-individual ownership as an institutional panacea (E. Ostrom, Janssen, and Anderies 2007).

The history and evolution of actually existing property regimes applicable to natural resources do not support the naïve theory, even as a first approximation. Instead, there is a vast array of complex property systems, including various combinations of private-individual, common, and public property rights that apply differentially to various natural resources on the basis not only of supply relative to demand, but also of many other variables, including the structure of underlying institutions (both social norms and formal laws), ecological conditions, and culture. Moreover, specific property regimes that prove viable and sustainable in one set of social-ecological circumstances (or in a single case) may prove nonviable or unsustainable in another (or many others). Just as the ecology of natural resources is highly complex and still not fully understood, so too are the property/regulatory systems that human societies deploy to manage, with greater or lesser success, those resources.

Empirical property-systems research not only belies the naïve theory of property rights, but also exposes Hardin's binary solutions to the tragedy of open access (private ownership or government regulation) as overly simplistic. Both private ownership and government regulation of access and use have not always successfully conserved natural resources. Coase (1964) has shown that government failure is just as important a category as market failure. Moreover, governments and markets can fail together. The Deepwater Horizon oil spill, arguably the worst environmental disaster in U.S. history, is only the most recent example of a combined government and market failure. The Marine Minerals Service of the Department of the Interior failed to regulate British Petroleum (BP) adequately because it suffered from an inherent conflict of interest: the revenues BP brought into the federal government caused the service to neglect its regulatory function.[2] Meanwhile, BP's private cost-benefit calculations of precautionary measures did not account for potentially catastrophic externalities. Most important, Hardin neglected viable alternatives to both private-individual ownership and government regulation, including self-organization and self-management by the resource users themselves (E. Ostrom 1990). Field studies, laboratory experiments, and appropriately structured games (Cole and Grossman 2010; E. Ostrom, Gardner, and Walker 1994) confirm that common property regimes are often, though not always, able to avert the tragedy of open access and conserve scarce resources over long periods of time.

[2] On the general problem of regulatory conflicts of interest and their effects on administrative oversight, see Cohen-Tanugi (1985) and Cole (1998).

One important goal of this book is to move beyond naïve, simplistic theories of commons tragedies and solutions by considering (or reconsidering) the wide variety of actually existing property systems applicable to natural resources that have evolved over time in response to changing social-ecological circumstances and to derive from those observations some implications for a more complex, but also more realistic and robust theory of property rights. Admittedly, the effort is complicated by the availability of multiple interpretive lenses through which any existing set of property institutions or regulations might be described or explained. For example, did the miners' codes adopted during the California gold rush constitute spontaneously organized property regimes (Umbeck 1981), agreements based on shared mental models (Anderson and Zerbe 2001), governance regimes more complex than simple contracts for property rights (Clay and Wright 2005), or attempted solutions to coordination games based on a wider variety of norms, including norms of fairness, at least some of which deviated significantly from basic tenets of American property law (McDowell 2002; 2004)? Even such conceptual disputes about the nature of actually existing institutions may contribute to a fuller and more realistic understanding of the nature and meaning of "property" as that term is applied to natural resources.

Defining Property Systems and Rights

The social science literature is replete with discussions of property rights and systems. However, conceptions of property differ significantly across that literature, and the phrase "property rights" and the term "institutions" are used in a wide variety of ways that are sometimes inconsistent (Alston, Eggertsson, and North 1996; North 1990). This volume is intended to lead to a better working definition of "property" as a concept and an institution or collection of institutions, as well as improved understanding of how various property systems have emerged, evolved, and developed (and continue to do so).

During the twentieth century, legal scholars focused predominantly on private property rights in land and often treated the right to exclude as the "*sine qua non* of property" (Merrill 1998, 730). Resource economists were preoccupied with private-individual property rights and often equated ownership with the right to alienate (Becker 1977). The focus on just a few specific private property rights was, of course, myopic and limited understanding of the wide variety of existing property systems for a long time.

Scholars from several disciplines, including history, economics, political science, law, sociology, and anthropology, have studied cases from around the world that illustrate the diverse ways in which resource users and other stakeholders have developed and instituted property-based governance regimes to manage those resources successfully and sustainably (Deininger, Ali, and Yamano 2008). Empirical research has contributed to a greater recognition and understanding of the diversity of rights and "bundles" of rights (Bromley 1989; Ciriacy-Wantrup and Bishop 1975; Wilson 1990; 2002; Wilson, Yan, and Wilson 2007).

From that research, scholars have distilled sets of rights that regularly apply to specific kinds of natural resources. Honoré (1961), for example, identified nine

distinct rights and two duties that are typically present in the case of full (fee-simple) ownership of land: (1) the right to exclusive possession; (2) the right to use; (3) the right to manage; (4) the right to the income; (5) the right to the capital; (6) the right to security; (7) transmissibility; (8) absence of term; (9) the prohibition of harmful use; (10) liability to execution; and (11) the right of residuary character. Of course, not all property is owned in fee simple. Lesser property interests would be categorized in Honoré's system by the absence of one or more distinct rights and duties. An owner of a conditional fee simple (such as fee simple to condition subsequent or fee simple determinable) would have only limited use and management rights; the term of his or her ownership interest could be cut short by a breach of the condition. A leasehold tenant would necessarily lack (5), (8), and (11). Mere licensees would have even fewer of the sticks from the full bundle of property rights.

Most property systems for water and other common-pool resources fail to exhibit many of Honoré's specific rights. Common-pool resources are large enough that it is costly to exclude potential beneficiaries, and they generate goods (resource units) whose extraction reduces the quantity of goods available to others (V. Ostrom and E. Ostrom 1977). Private rights to common-pool resources tend to be more limited, correlative, contingent, and attenuated than those applicable to land. Broadly considering ownership rights in common-pool resources, including many fishery and water resources, Schlager and Ostrom (1992) discerned five distinct property rights in use:

1. Entry: the right to enter a resource, which could be achieved by buying a ticket to enter a state park for a day or a month, by declaration of a national or state government that all citizens of the nation or state could enter footpaths or property of a wide diversity of kinds, or by inheritance of joint use rights.
2. Withdrawal: the right to harvest and take some resource units out of the resource system. Those who purchase a permit, for example, obtain a right to extract various kinds of resource units, including fish, nontimber forest products, firewood, timber, and diverse amounts of water.
3. Management: the right to change the physical structures in a resource system, such as building an irrigation system or a road, changing the shoreline of a fishery, or developing a variety of physical infrastructures for any particular resource.
4. Exclusion: the right to determine who else could use the resource and what their specific rights would be.
5. Alienation: the right to sell one or more of the first four rights permanently or for a given time period. Most attention has been given to the right to transfer full ownership of a segment of a resource that would involve having all four of the other rights. Some forms of alienation are not that general, but still assign the right to sell some meaningful subset of the rights that are held by a participant.

Schlager and Ostrom's list of property rights in common-pool resources significantly overlaps with Honoré's list of private property rights in land, but the differences between the two sets of rights may be more important than the commonalities. Moreover, one should not blithely assume that scholars mean the same thing by their designations and descriptions of various property rights. There is still no standard,

cross-disciplinary agreement on a common set of names, contents, and meanings of the term "property right" (Cole and Grossman 2002). The problem, then, is how to define this term.

What makes a right a right? Must it be enforceable by a court of law? Does the term "right" incorporate lesser interests (or entitlements), such as licenses, permissions, or mere unimpeded uses? Nearly one hundred years ago, the legal scholar Wesley Newcomb Hohfeld designed a powerful analytic system for understanding the nature of various legal entitlements and burdens, including rights and duties (Hohfeld 1913; 1917) (see table 2.1). The most important aspect of that system for present purposes is Hohfeld's correlation of right and duty, according to which one cannot be said to possess a "right," including a "property right," unless one can identify at least one other person who possesses an enforceable, corresponding duty of noninterference. Unfortunately, Hohfeld's system has not been widely followed outside the legal academy and remains somewhat controversial within it (but see Singer 2006).[3] Some social scientists, including Barzel (1989), throw around the word "right" casually and without clear definition (Cole and Grossman 2002). In this chapter, the term "right" is used in Hohfeld's strict sense.

Similar problems attend the term "property," which, if anything, is even less well defined than the term "right." It is not clear, in the first place, what makes a certain right a "property right," as opposed to a "personal right," a "human right," or some other kind of right. Even if we assume that such distinctions make sense, on what basis do we distinguish these different types of rights? What, if anything, makes "property" special? Is it anything more than a descriptive appendage to the term "right," signifying that the right relates to things, including incorporeal things, such as shares of communal or corporate assets?[4]

When scholars have focused on parsing specific private property rights governing various resources under different systems, they have sometimes neglected higher-order categorizations of property systems, which have their roots (but not necessarily their modern understandings)[5] in Justinian's compilation of Roman law: *res privatae*

TABLE 2.1
Hohfeld's Jural Relations

Correlatives	Opposites
Right/duty	Right/no-right
Privilege/no-right	Privilege/duty
Power/liability	Power/disability
Immunity/disability	Immunity/liability

SOURCE: Hohfeld (1913; 1917).

[3] For a description of legal/jurisprudential critiques of Hohfeld's jural relations and a strong defense of Hohfeld's system, see Lazarev (2005). V. Ostrom and E. Ostrom (1972) analyze the work of Hohfeld (1917) and Commons (1959) as a foundation for analyzing water rights and water development.

[4] In Hohfeld's system of jural relations, "all legal interests are 'incorporeal,' consisting, as they do, of more or less limited aggregates of *abstract* legal relations" (1913, 24; emphasis in original).

[5] It needs to be stressed that the conventional typology of property systems sketched here reflects modern understandings of the Roman law property categories, rather than the original Roman conceptions. Significant differences include the treatment of *res nullius* and *res communes*. At Roman law, *res nullius* or nonproperty was capable of

(private property), *res publicae* (public property), *res communes* (common property), and *res nullius* (nonproperty) (see table 2.2).

These Roman law categories arguably are incoherent or at least incomplete. Few, if any, real-existing property arrangements fit within a single category. Is a corporation, for example, better described as private property or common property? When is local self-government public, as opposed to common, property? Might not common property resources be described as the private property of each individual member of the common ownership group? Because of the lack of coherence and completeness in the description of property systems, scholars have sometimes confused or conflated Roman law property types, but they can take solace in the fact that the Roman lawyers who first developed them also did so. Consider the following sections from Justinian's *Institutes*:

TABLE 2.2

Conventional Typology of Property Systems

State/public property	The state or its agencies have the right to determine rules of access and use, but a duty (at least in theory) to manage publicly owned resources for the public welfare. Individual members of the public do not necessarily have a right of access or use, but they have a duty to observe access and use rules promulgated by the controlling/managing agency.
Private property	Owners have the exclusive right to undertake socially acceptable uses to the exclusion of nonowners, and they have a duty to refrain from socially unacceptable uses. Nonowners have a duty to refrain from preventing owners' socially acceptable uses, but they have the right to prevent or be compensated for socially unacceptable uses.
Common property	Each member of the ownership group has the right to access and use group-owned resources in accordance with access and use rules established collectively by the group, and a duty not to violate access and use rules. Each member also has the right to exclude nonmembers of the ownership group, but no right to exclude other members of the ownership group. Nonmembers of the ownership group have a duty not to access and use the resource except in accordance with rules adopted collectively by the ownership group.
Nonproperty/open access	No individual has a duty to refrain from accessing and using a resource. No individual or group has the right to prevent any other individual or group from accessing and using the resource as they choose.

SOURCE: Adapted from Bromley (1991).

appropriation, that is, conversion to *res privatae* through acts of possession and occupation; and *res communes* referred to things not susceptible to private or state ownership, such as the open seas. *Res communes* originally designated open-access resources (Rose 2003; Sohm [1907] 1994). Today, however, most scholars treat the Roman category of *res nullius* or nonproperty as synonymous with open access; it is unowned by anyone and open to all users. The term *res communes*, by contrast, now denotes property co-owned by one group to the exclusion of others (E. Ostrom 1990). However, some scholars (e.g., Freyfogle 2002; Platt 2004) distinguish "open-access commons" from "closed-access commons."

> *Section I.*—These things are, by the Law of Nature, common to all mankind,—air, running water, the sea, and consequently the shores of the sea. No one, therefore, is forbidden to approach the shore of the sea, providing he abstain from injuring houses, monuments and buildings, for these are not of common right, as is the sea.
>
> *Section II*—All rivers, also, and ports are public property, therefore all men have a common right to fish in a port, or in rivers.
>
> . . .
>
> *Section V.* —The use of the shores of the sea is as public, and common to all men as is the sea itself; therefore any person is permitted to build a house there, for his habitation, or to dry his nets, and draw up anything from the sea upon the shore. The property of the shore, however, must be understood to be vested in no individual, but to partake of the same legal nature as the sea itself, and the soil or sand which is beneath it. (Grapel 1994 [1855], 50)

Nearly all property scholars are familiar with section I, but few have paid due attention to sections II and V, which confirm that Roman lawyers failed to delineate clearly the content of the property categories they established. In asserting that the air and waters are "common to all mankind" and constitute "public property," so that "all men have a common right to fish in a port, or in rivers," Justinian's lawyers conflated common property with public property and both of those property categories with open access. A similar problem arises from the assertion that "any person is permitted to build a house" on the seashores because they are "public" property and "common to all men."[6] Conceptual confusions over property systems are not a modern invention, but seemingly date back to the very Roman lawyers who first described them.

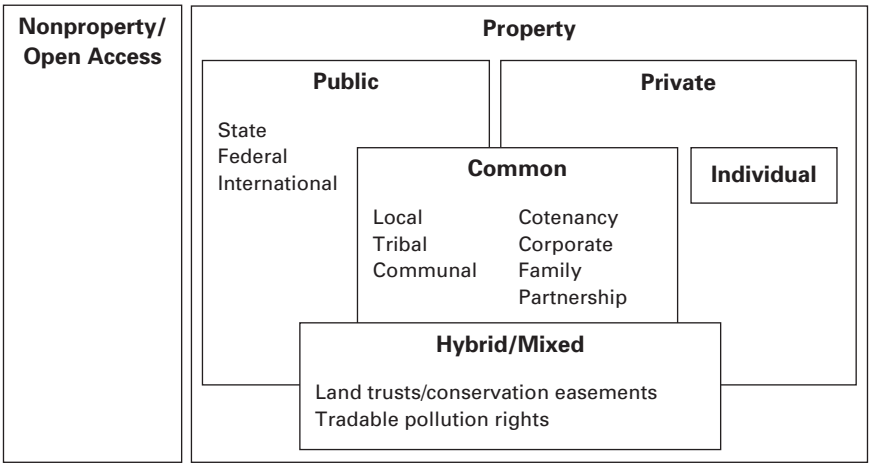
Figure 2.1 provides a graphic representation of the Roman law property systems (plus hybrids) in a way that illustrates the conceptual problems they generate. The nonproperty/property and public/private property dichotomies seem clear enough, but once common property and hybrid systems are added, distinctions become blurred. In a more realistic depiction of actual property relations, the category "hybrid property" would probably blot out all other systems. Virtually all real-existing property systems contain admixtures of private, public, and common rights. There is no such thing as purely private or purely public property (Cole 2002).

The old Roman law property categories seem increasingly obsolete in a world of mixed, hybrid, and nested property systems. Nevertheless, they continue to serve as the conventional types for purposes of description, comparison, and analysis. Is it finally time to replace them?

More important, perhaps, than improving or replacing the conventional typology of property systems passed down from Roman lawyers is learning about the specific rights and duties meant by the phrases "private property," "public property," and "common property" as applied in particular locations. Bromley observed that

[6] A different translation of the *Institutes* refers to "hut" instead of "house" and to "shelter" rather than "habitation" (Birks and McLeod 1987, 55). This alternative translation suggests a more temporary arrangement, rather than permanent occupancy. We are grateful to Richard Epstein for directing us to this alternative translation.

FIGURE 2.1
Relations of Property Systems



SOURCE: Cole (2002).

those who write about property systems and rights are only rarely "specific about the content of those terms" (1989, 187). When someone uses the phrase "private property," it is often difficult to tell whether that person means something like Blackstonian absolute dominion (Blackstone 1979 [1766]), which did not really exist even in Blackstone's time (Rose 1998), or something more like modern real estate ownership, which is subject both to the correlative rights of neighbors and to substantial government control.

Roman Law Conceptions of Property and the Sustainability of Natural Resources

Even though the broad types of property rights as traditionally defined are characterized by conceptual problems, one or another of them is frequently recommended as the best way to manage natural resources in a sustainable manner. Advocacy for idealized types of property rights relies on a widely accepted view in the environmental management literature that property rights over land or other natural resources are required in order to provide the appropriate incentives for conservation to users (Hanna and Munasinghe 1995). It is presumed that if someone does not "own" a resource, that person does not have long-term interests in sustaining that resource and thus cannot be expected to act beneficially toward it. Without property rights, open-access conditions prevail, which frequently do lead to environmental destruction when users are located near a resource and are interested in harvesting from it.

Instead of recognizing the diversity of rules actually used in the governance of resources that are sustained over long periods of time, much of the policy literature strongly recommends private or government ownership, with a strong bias for governmental property rights systems. One important example is the repeated recommendation of protected areas and national parks. Public ownership with stringent formal regulations regarding use patterns is recommended by some as the silver bullet to achieve biodiversity conservation (Lovejoy 2006; Terborgh 1999; Dowie

2010 [on observing that formal institutions designed to protect biodiversity sometimes harm indigenous cultures]). Empirical studies are uncovering a diversity of institutions, however, that achieve sustainable development, as well as those that do not (E. Ostrom 2005). Many factors beyond the generalized names associated with the idealized property rights systems discussed earlier are associated with achievements in the field (Grafton 2000). What are some of the attributes of resources in the field that are conducive to private property, and why have some of the heralded policies not performed as recommended in the policy literature?

Attributes of Resources Conducive to Individual Ownership

The advantage of individual ownership of strictly private goods, where the cost of exclusion is relatively low and one person's consumption subtracts from what is available to others, is so well established that it does not merit attention here. Industrial and agricultural commodities clearly fit the definition of private goods. Individual rights to exclusion and to transfer of control over these goods generate incentives that tend to lead to higher levels of productivity than other forms of property arrangements.

It has frequently been assumed that land is also best thought of as a private good and therefore is most efficiently allocated by using market mechanisms based on individual ownership rights. Gaining formal title to land, however, may or may not increase efficiency. Feder et al. (1988) conducted an important econometric study that showed that agricultural land in Thailand without a formal title was worth only one-half to two-thirds as much as land with a formal title. Further, increasing the security of private property rights also led to an increased value of the crops produced (between one-tenth and one-fourth higher than the value of those from land without a secure title). More secure titling also provided better access to credit and led to greater investments in improved land productivity (see also Feder and Feeny 1991).

Title insurance is one mechanism used to reduce the risk of challenges to ownership of land. Registering brands is another technique used to increase the security of ownership over resource units in the form of cattle that may range freely over a large area until there is a communal effort to undertake a roundup. Gaining formal titles, however, is costly. In societies that do not yet have high population densities and in which customary rights are still commonly understood and accepted, formal titling may be an expensive method of increasing the security of a title that is not associated with a sufficiently higher return to be worth the economic investment (Migot-Adholla et al. 1991). In addition, the cost of fencing land by physical and/or institutional means is nontrivial, and there are types of land and land uses that may be more efficiently governed by groups of individuals than by single individuals.

A commonly recommended solution to problems associated with the governance and management of mobile resources units, such as water and fish, is their privatization (Christy 1973; Clark 1980). What private ownership usually means in regard to mobile resource units, however, is ownership of the rights to withdraw a quantity of a resource unit and the right to alienate this harvesting right. Water rights are normally associated with the allocation of a particular quantity of water per unit of

time or the allocation of a right to take water for a particular period of time or at a particular location. Fishing rights are similarly associated with quantity, time, or location. These rights are typically withdrawal rights that are tied to resource units and not to a resource system.

Some coastal fisheries in Canada, New Zealand, and Iceland have been able to develop individual transferable quota (ITQ) systems that have reduced the level of harvesting. In British Columbia, early governmental policies trying to control overfishing of the trawl fishery for groundfish included restricting the number of fishing vehicles and the equipment that could be used and assigning quotas of total allowable catch and fishing trips. In 1995 the fishery was closed, however, because of a major collapse. The government reopened the fishery several years later with new regulations, including an annual ITQ system (Clark 2006). In addition, it established a rigorous monitoring program in which onboard observers record all catches. The ITQ system has collected more valid data, decreased fleet overcapacity, recorded catch levels that are close to the allocated quotas, and reduced discard of unwanted species. Thus, the British Columbia ITQ system has had positive impacts on the fishery. In addition to the allocation of fishing rights each year, an effective and costly monitoring system has also been an essential aspect of this success. ITQ systems that do not have an effective monitoring system have suffered from considerable underreporting of catch levels.

New Zealand declared its two-hundred-mile Exclusive Economic Zone in 1983. In 1986 New Zealand became one of the first countries to adopt a market-based fishery regulation when it adopted its Quota Management System and allocated ITQs to a subset of domestic fisheries (Yandle and Dewees 2003). New Zealand authorities found that the biological models underlying the initial assignment of permanent allocations of fixed quotas needed to be adjusted over time in light of further evidence. As a result, in 1990 the commercial fishers received a revised ITQ based on a proportion of the total catch assigned annually (Yandle 2007). Over time, the original ITQ system has evolved into a comanagement system in which the fishers participate in gathering data and making policies. The system is still evolving and faces problems related to mismatches among the temporary and spatial dimensions of the property rights assigned to diverse groups (Yandle 2007).

In 1990 Iceland also introduced an ITQ system that is similar to the evolved New Zealand ITQ system. Quotas are not fixed quantities, but rather a share of the annual authorized catch level set by the government (Arnason 1993). Iceland's ITQ system appears to have averted the collapse of many valuable species for the Iceland fishery, but it has been less successful in restoring Icelandic cod stocks. In his analysis of the long and conflict-ridden road to the Icelandic ITQ system, Eggertsson (2004; 2005) reflects that introducing major institutional changes is a subtle art compared with using a simpler one-size-fits-all formula. Designing a top-down system and imposing it on the harvesters is not as successful as working with the users of a resource over time to develop a system that is well matched to the ecological system, as well as to the practices, norms, and long-term economic welfare of the participants, as was eventually accomplished in New Zealand.

Although the fishers have rights to the quotas or "fishing units," they do not own the fishing stock. Governmental units exercise various types of management rights

in relationship to these stocks, which thus constitute public or state property before private allocation or appropriation. In groundwater basins that have been successfully litigated, individual pumpers own a defined quantity of water that they can produce, rent, or sell, but the groundwater basins themselves may be managed by a combination of general-purpose and special-purpose governmental units and private associations (Blomquist 1992; Steed 2010).

Implementing operational and efficient individual withdrawal rights to mobile resources is far more difficult in practice than demonstrating the economic efficiency of hypothetical systems (Yandle 2001). Simply gaining valid and accurate measurements of "sustainable yield" is a scientifically difficult task. In systems where resource units are stored naturally or by constructing facilities such as a dam, the availability of a defined quantity of the resource units can be ascertained with considerable accuracy, and buying, selling, and leasing rights to known quantities are relatively easy to achieve in practice. Many mobile resource systems do not have natural or constructed storage facilities, and gaining accurate information about the stock and reproduction rates is costly and involves considerable uncertainty (Allen and McGlade 1987; Wilson et al. 1991). Further, as Copes (1986) has clearly articulated, appropriators from such resources can engage in a wide diversity of evasive strategies that can destabilize the efforts of government agencies trying to manage these systems. Once such systems have allocated individual withdrawal rights, efforts to regulate patterns of withdrawal further may be difficult and involve expensive buyback schemes. Experience with these individual withdrawal rights systems has varied greatly in practice (McCay 1992; McCay et al. 1996; Pinkerton 1992; 1994; Wilson et al. 1994). Further, efficiency is not the only criterion that should be taken into account in analyzing the effect of privatizing essential goods, such as water (Frohlich and Oppenheimer 1995).

Exactly which attributes of both physical and social systems are most important to the success of individual withdrawal rights from common-pool resources is not as well established as the attributes of common-pool resource systems conducive to group proprietorship or ownership. On the physical side, gaining accurate measurements of the key variables (quantity, space, technology) that are to be involved in management efforts is essential. Resource systems that are naturally well bounded facilitate measurement, as well as ease of observing appropriation behavior. Storage also facilitates measurement. Where resource units move over vast terrains, the cost of measurement is higher than when they are contained. For example, it is easier to develop effective withdrawal rights systems for lobsters than for whales.

Considerable recent research has also stressed the importance of involving participants in the design and implementation of individual withdrawal rights systems (Yandle and Dewees 2003). When participants do not look on such rules as legitimate, effective, and fair, the incentive to invent evasive strategies is substantial (Seabright 1993; Wilson 1995). The very process of allocating quantitative and transferable rights to resource units may, in fact, undo some of the common understandings and norms that allowed communal ownership systems to operate at lower day-to-day administrative costs.

Finally, even where the costs of establishing, implementing, and monitoring private property rights in resource systems are manageable, sustainable levels of resource

extraction are not guaranteed. Clark, for example, observes that the "extermination of an entire [whale] population may appear as an attractive policy, even to an individual resource owner," when "(a) the discount (or time preference) rate sufficiently exceeds the maximum reproductive potential of the population, and (b) an immediate profit can be made from harvesting the last remaining animals" (1973b, 950–951; also see Clark [1973a]; Cole [2002]; Larson and Bromley [1990]; Schlager and Ostrom [1992]). Clark's findings are supported by other empirical studies, including Fidzani's (2000) investigation of the effects of privatization on pastureland degradation in Botswana and Hurst's (1984) study of deforestation of private timberlands in Wisconsin. Even when individual private ownership is practicable, then, it is not a panacea for resource conservation.

Comparing Farmer-Managed and Agency-Managed Irrigation Systems in Nepal

Although the evidence regarding the use of private property for sustainable resource use is not generally positive, some very creative common property regimes have a higher success rate. A brief description of research findings related to irrigation systems and forests illustrates the importance of unpacking broad property concepts to understand why some work effectively in some settings but are not universally applicable.

Rice farmers are highly dependent on how effectively the irrigation systems serving their land work. No irrigation system works well, however, without agreed-on rules for allocating both water and responsibilities to provide the needed labor, materials, and money to build the system and maintain it over time. Until the 1950s, farmers in Nepal built all the farmer-managed irrigation systems (FMISs) that they used to supply water to irrigate paddy rice fields because the central government did not take any responsibility for planning, building, or maintaining these systems. In the mid-1950s a Department of Irrigation was established that articulated and developed a series of five-year plans to add new systems to the many FMISs that the farmers had established. Since then, international development agencies (including the Asian Development Bank and the World Bank) have invested large sums in designing and constructing large-scale irrigation systems that were turned over to the national government to be agency-managed irrigation systems (AMISs). The existence of two broad ownership patterns for irrigation systems has provided an excellent opportunity to compare the performance of systems built and organized by farmers with that of systems designed by engineers and then owned by a national government.

Researchers associated with the Institute of Agriculture and Animal Science at Tribhuvan University in Nepal have been working with colleagues at Indiana University since the early 1990s (Benjamin et al. 1994; Lam, Lee, and Ostrom 1997). They jointly developed the Nepal Irrigation Institutions and Systems (NIIS) database that now has information on more than 225 irrigation systems located in 29 of the 75 districts in Nepal (Joshi et al. 2000).[7] The consistent finding is that on average, FMISs

[7] The findings discussed in this chapter are based on data that were mostly collected in earlier peaceful times.

TABLE 2.3

Relationships Between Governance Structure and Physical Condition of Irrigation Systems

Physical Condition of Irrigation Systems		Type of Governance Structure		Chi-Square Value	Significance
		FMIS (%)	AMIS (%)		
Overall condition	Excellent [37]	18.2	8.4	23.02	.00
	Moderately good [144]	67.4	45.8		
	Poor [48]	14.4	45.8		
Technical efficiency	Highly efficient [58]	28.9	12.5	27.30	.00
	Moderately efficient [137]	62.8	50.0		
	Inefficient [33]	8.3	37.5		
Economic efficiency	Highly efficient [66]	33.2	12.5	45.35	.00
	Moderately efficient [140]	63.5	52.1		
	Inefficient [23]	3.3	35.4		

SOURCE: Joshi et al. (2000).

NOTE: Numbers of irrigation systems are in brackets.

outperform AMISs on multiple dimensions. A very brief overview of these findings is presented here.

In regard to the physical condition of the irrigation system at the time of data collection, as shown in table 2.3, a larger proportion of FMISs than of AMISs are able to maintain the overall physical condition of a system in excellent or moderately good condition and to achieve higher technical and economic efficiency (see Lam 1998 for definitions of these terms as used in the NIIS database). The better physical condition of the canals enables FMISs to achieve increased levels of cropping intensity (the number of crops grown during a year) at both the head end and the tail end of a canal, as shown in table 2.4. Thus, the investment of farmers in keeping their systems in good physical condition pays off in significantly more agricultural productivity.

Approximately two-thirds of both the FMISs and AMISs have formal written rules that include provisions for imposing fines on farmers who do not contribute resources to operate and manage the systems (Joshi et al. 2000). In eight out of ten AMISs, an official guard is hired to monitor the system, while only six out of ten FMISs rely on an official guard. The presence of an official guard, however, does not increase the likelihood that fines are actually imposed. On 75 percent of the FMISs, fines are reliably imposed if farmers are observed to break a rule, while fines are imposed on only 38 percent of the AMISs (Joshi et al. 2000). Farmers follow the rules of their system to a greater extent on FMISs than on AMISs, and they also tend to achieve a higher level of mutual trust.

The specific rules that farmers use in governing their systems on a day-to-day basis vary substantially from one system to another (Shivakoti and Ostrom 2002). Some FMISs use a rotational system where each farmer has a right to extract water from the canal at a particular time during a week. Others located in zones of abundant

TABLE 2.4

Relationships Between Governance Structure and Cropping Intensity of Irrigation Systems

Cropping Intensity		Type of Governance Structure		Chi-Square Value	Significance
		FMIS (%)	AMIS (%)		
Intensity at head end	High [142]	70.2	52.2	5.27	.02
	Low [72]	29.8	47.8		
Intensity at tail end	High [123]	65.1	34.1	13.74	.00
	Low [87]	34.9	65.9		

SOURCE: Joshi et al. (2000).

NOTE: Numbers of irrigation systems are in brackets.

water allow authorized farmers to extract any amount of water they need from a continuous supply in the canal. Most systems change the rules in use during the monsoon season, as contrasted with the drier periods of the year (Shukla 2002). The rules specifying water allocation, as well as responsibilities to monitor and to impose sanctions for rule breaking, are thus not consistent from one system to the next. The "official" guard on many of the FMISs is one of the farmers who rotates into this position on a regular basis. Thus, the monitoring of water allocation and contributions to maintenance is largely performed by farmers who have participated in the crafting of the specific rules of their system and have a strong interest in seeing their system perform well and ensuring that others on the system are not free riding or taking more water than their official share (E. Ostrom, Lam, et al. 2011).

Comparing Government, Private, and Community-Owned Forests Around the World

In the early 1990s, Dr. Marilyn Hoskins at the Food and Agriculture Organization of the United Nations asked colleagues at the Workshop in Political Theory and Policy Analysis at Indiana University to initiate an extensive multicountry research program to study the impact of diverse institutional arrangements on forests and the people relying on forests in Africa, Asia, Latin America, and the United States. Colleagues at the Workshop drew on their general research on institutional diversity and their research on Nepal irrigation systems to develop the International Forestry Resources and Institutions (IFRI) research program and an extensive database (Gibson, McKean, and Ostrom 2000). The purpose of the study was to gain a scientifically rigorous understanding of the variety of factors that affect forest sustainability. The desire was to develop a network of collaborating centers located in many countries around the world that would conduct comparable studies in each of their countries. At the present time, Arun Agrawal of the University of Michigan is coordinating the IFRI research program and working with collaborating research

centers in Bolivia, Colombia, Guatemala, India, Kenya, Mexico, Nepal, Tanzania, Thailand, Uganda, and the United States (http://www.sitemaker.umich.edu/ifri/home).

As mentioned earlier, government-owned protected areas are frequently recommended as the way to preserve the ecosystem services generated by forests (Terborgh 1999), but they are also criticized for having few effective rules (Busch 2008; Sheil et al. 2006). Given the repeated recommendations that government-owned protected areas are the way to sustain forest ecosystems, it is not surprising that national governments own roughly 86 percent of the world's forests. Further, protected areas have grown to cover approximately 6.4 million square kilometers of forest globally (Agrawal, Chhatre, and Hardin 2008). Formal ownership of forest resources by itself, however, is not strongly related to their sustainability. Agrawal, Chhatre, and Hardin conclude that "the effectiveness of forest governance is only partly explained by who owns forests. At the local level, existing research finds only a limited association between whether forests are under private, public, or common ownership and changes in forest cover or sustainability of forest management" (2008, 1462).

In an effort to examine whether government ownership of protected areas is a necessary condition for improving forest density, Hayes (2006) used IFRI data to compare broad forest governance types via a rating of forest density (on a five-point scale) assigned to a forest by the forester or ecologist who supervised the forest mensuration of trees, shrubs, and ground cover in a random sample of forest plots.[8] Of the 163 forests included in the analysis, 76 were government-owned forests legally designated as protected forests, and 87 were public, private, or communally owned forested lands used for a wide diversity of purposes. No statistical difference was found between the forest densities in officially designated protected areas and in all other forested areas.

Robbins et al. (2007) reported on a study of the spatial distribution of vegetation change over time at the Kumbhalgarh Wildlife Sanctuary in the Aravalli range of Rajasthan in India. Instead of no change, as hoped for by proponents of protected areas, their results showed that 28 percent of the study area was undergoing change, although in multiple trajectories, with both increasing and decreasing density of vegetation in discrete patches. Areas closer to entrance points had a higher level of change than areas located within the reserve. They concluded that the patchiness resulted from the complex challenges faced by middle- and lower-level officials in the Forest Department's bureaucracy. The rules are the same, but the results differ across space. Thus, even in one reserve, using a frequently recommended general property right does not have uniform results.

Although scholars do not find a consistent relationship between forest conditions and the very broad terms used to describe property regimes for forests, activities related to monitoring and rule enforcement are generally important. Gibson,

[8] Extensive forest mensuration is conducted at every IFRI site at the same time at which information is obtained about forest users, their activities and organization, and governance arrangements. Comparing forest measures across ecological zones is misleading because the average diameter at breast height in a forest is strongly affected by precipitation, soils, elevation, and other factors that vary dramatically across ecological zones. Thus, the forester or ecologist who has just supervised the collection of forest data is asked to rate the forest on a five-point scale from very sparse to very abundant.

Williams, and Ostrom (2005) examined the monitoring behavior of 178 forest user groups and found a strong and statistically significant correlation between the level of monitoring and a forester's assessment of forest density when they controlled for many other variables. Chhatre and Agrawal (2008) examined the changes in the condition of 152 forests under diverse governance arrangements as affected by the size of the forest, collective action in forests related to improvement activities, size of the user group, and the dependence of local users on a forest. "Forests with a higher probability of regeneration are likely to be small to medium in size with low levels of subsistence dependence, low commercial value, high levels of local enforcement, and strong collective action for improving the quality of the forest" (Chhatre and Agrawal 2008, 13287). Studies by Coleman (2009) and Coleman and Steed (2009) also find that a major variable affecting forest conditions is investment by local users in monitoring. Further, when local users are allocated harvesting rights, they are more likely to monitor illegal uses themselves. Other focused studies also stress the relationship between local monitoring and better forest conditions (Banana and Gombya-Ssembajjwe 2000; Ghate and Nagendra 2005; E. Ostrom and Nagendra 2006; Webb and Shivakoti 2008).

IFRI research shows that forests under different property regimes (government, private, or communal) sometimes meet enhanced social goals, such as biodiversity protection, carbon storage, or improved livelihoods. At other times, any of these general property systems may fail to meet such goals. Thus, it is not the general system of property rights used for forest governance that is crucial in predicting whether forest conditions are sustainable. Rather, it is how a particular governance arrangement fits the local ecology, how the specific rules of a governance regime are developed and adapted over time, and whether users consider the system to be legitimate and equitable (for a more detailed overview of the IFRI research program, see Poteete, Janssen, and Ostrom 2010). Property rights are indeed important in affecting resource conditions, but the general names assigned to government, private, or community property regimes do not discriminate among the types of rules used in practice.

Diversity Rather than Uniformity of Rules in Property Rights Systems

Groups of individuals are considered to share common property rights when they have formed an organization that exercises at least the collective-choice rights of management and exclusion in relationship to a defined resource system and the resource units produced by that system. Communal groups most frequently establish some means of governing themselves in relationship to a resource. When communal groups are full owners, members of the group have the further right to sell their access, use, exclusion, and management rights to others, subject in many systems to approval by other members of the group.

Some communal ownership regimes are formally organized and recognized by legal authorities as having a corporate existence. Other communal proprietorships are less formally organized and may exercise de facto property rights that may or may not be supported by legal authorities if they are challenged by nonmembers

(Ghate 2000). Obviously, such groups hold less well-defined bundles of property rights than those that are secure in their de jure rights, even though the latter may not hold the complete set of property rights defined as full ownership. In other words, well-defined and secure property rights may not involve the right to alienation. Further, "communal" land tenure regimes in Africa and other developing countries are not as static and tradition bound as they are frequently portrayed in the literature (Cousins 2009). The specific attributes of land rights systems tend to evolve over time, but if government officials do not understand indigenous systems, the reforms they propose may be counterproductive.

Even though all common-pool resources are characterized by high costs of devising methods to achieve exclusion and determination of who owns the subtractable resource units, other attributes of these resources that affect the incentives of resource users and the likelihood of achieving outcomes that approach sustainability vary immensely. Further, whether it is difficult or costly to develop physical or institutional means to exclude nonbeneficiaries depends both on the availability and cost of technical and institutional solutions to the problem of exclusion and on the relationship of the cost of these solutions to the expected benefits of achieving exclusion from a particular resource.

Consider land as a resource system. Where population density is extremely low, and land is abundant and generates a rich diversity of plant and animal products without much husbandry, the expected costs of establishing and defending boundaries to a parcel of land of any size may be greater than the expected benefits of enclosure (Feeny 1993). Settlers moving into a new terrain characterized by high risk due to danger from others, from a harsh environment, or from lack of appropriate knowledge may decide to develop one large, common parcel before any divisions into smaller parcels (Ellickson 1993). Once land becomes scarce, conflict over who has the rights to invest in improvements and to reap the results of his or her efforts can lead individuals to want to enclose land through fencing or institutional means to protect their investments. Trade-offs in costs need to be considered. The more land included within one enclosure, the lower the costs of defending the boundaries, but the costs of regulating uses of the enclosed parcel may be higher than for small parcels.

The decision to enclose need not be taken in one step from an open-access terrain to a series of private plots owned exclusively by single families (Ellickson 1993; Field 1984; 1985; 1989). The benefits of enclosing land depend on the scale of productive activity involved. For some agricultural activities, considerable benefits may be associated with smaller parcels fully owned by a family enterprise. For other activities, the benefits of household plots may not be substantial. Moving all the way to private plots is efficient when the expected marginal returns from enclosing numerous plots exceed the expected marginal costs of defending a much more extended system of boundaries and the reduced transaction costs of making decisions about use patterns within boundaries (Nugent and Sanchez 1995).

In a classic study of the diversity of property rights systems used for many centuries by Swiss peasants, Robert Netting (1976; 1981) pointed out that the farmers fully divided their agricultural land into separate family-owned parcels. The grazing lands located on the Alpine hillsides, however, were organized into common property

systems. For centuries, the same individuals used different property rights systems for different ecologies located side by side in these mountain valleys. Each local community had considerable autonomy to change local rules, so there was no problem of someone else imposing an inefficient set of rules on it. Netting argued that attributes of the resource affected which property rights systems were likely for diverse purposes. He identified five attributes that he considered most conducive to the development of common property rights systems:

1. Low value of production of resource units per unit of area.
2. High variance in the availability of resource units on any one potential parcel.
3. Low returns from intensification of investment.
4. Substantial economies of scale by utilizing a large area.
5. Substantial economies of scale in building infrastructures to utilize large areas.

Although the Swiss peasants were able to devote these harsh lands to productive activities at low cost, they had to invest time and effort in the development of rules that would reduce the incentives to overgraze and would ensure that investments in shared infrastructure were maintained over time. In many Swiss villages, "cow rights" to common pasturage were distributed according to the number of cows that could be carried over the winter by using hay supplies provided by the owner of the cows. Each village determined who would be allowed to use the Alpine meadow, the specific access and withdrawal rights to be used, how investment and maintenance costs were to be shared, and the formula used to share the annual returns from selling cheese made by the community from the cows milked in the Alpine meadows. All these systems included at least village proprietorship rights, but some Swiss villages developed full ownership rights by incorporating and authorizing the buying and selling of shares (usually with the approval of the village).

Netting's findings about the association of patchiness of a resource with common property arrangements are not unique. They are strongly supported by studies of mountain villages in Japan, where thousands of rural villages have held communal property rights to extensive forests and grazing areas located in the steep mountainous regions located above their private agricultural plots (McKean 1982; 1992). Similar systems have existed in Norway for centuries (Örebech 1993; Sandberg 1993; 2007), as well as in Ireland (Di Falco and van Rensburg 2008). The Masai herders of Kenya faced a patchy environment that they were able to develop before colonial rule by a set of rules allowing pastoral groups to move to regions within a large, jointly owned territory that had received the highest level of rainfall in recent times (Mwangi and Ostrom 2009). Patchy land environments in India are allocated in complex ways to farmers for part of the year and to roving pastoralists to graze their animals on the stubble and to fertilize fields during the other parts of the year (Agrawal 1999; Kaul 1996).

The importance of sharing risk is stressed in other theoretical and empirical studies of communal proprietorships (Antilla and Torp 1996; Bardhan and Dayton-Johnson 2002). Further, land rights that enable users to adapt to complex ecological conditions tend to be stronger than those that limit self-organized change (Lambin,

Geist, and Lepers 2003). Unpredictability and risk are increased in systems where resource units are mobile and where storage facilities, such as dams, do not exist (Schlager, Blomquist, and Tang 1994). Institutional facilities for sharing risk, such as formal insurance systems or institutionalized mechanisms for reciprocal obligations in times of plenty, also affect the kinds of property rights systems that individuals can devise. When no physical or institutional mechanisms exist for sharing risk, communal property arrangements may enable individuals to adopt productive activities not feasible under individual property rights. Empirical studies have shown that variance in the productivity of land over space, due largely to fluctuations in rainfall from year to year, is strongly associated with the size of communally held parcels allocated to grazing in the Sudan (Nugent and Sanchez 1995). Ellickson (1993) compares the types of environmental and personal security risks faced by new settlers in New England, in Bermuda, and in Utah to explain the variance in the speed of converting jointly held land to individually held land in each of these settlements.

A finding of many studies of common property systems is that these systems do not exist in isolation and are frequently used in conjunction with individual ownership. In most irrigation systems that are built and managed by farmers, such as those in Nepal discussed earlier, each farmer owns an agricultural plot (or plots) while participating as a joint proprietor or owner in a communally organized irrigation system (Coward 1980; Sengupta 1991; 1993; Tang 1992; Vincent 1995; Wade 1992). Water is allocated to individual participants under a variety of individually tailored rules, but those irrigation systems that have survived for long periods of time tend to allocate water and responsibilities for joint costs using a similar metric, frequently the amount of land owned by a farmer. In other words, benefits are roughly proportional to the costs of investing in and maintaining the system itself.

Further, formally recognized communal systems are usually nested in a series of governance units that complement the organizational skills and knowledge of those involved in making collective-choice decisions in smaller units. Since the Middle Ages, most of the Alpine systems in both Switzerland and Italy have been nested in a series of self-governing communities that respectively governed villages, valleys, and federations of valleys (Merlo 1989).

Factors Affecting the Performance of Common Property Regimes

The performance of common property systems varies substantially, as does the performance of all property rights systems. Some common property systems fail or limp along at the margin of effectiveness, just as private firms fail or barely hang onto profitability over long periods of time. In addition to the environmental variables discussed earlier that are conducive to the use of common property arrangements, the following variables related to the attributes of participants are conducive to their selection of norms, rules, and property rights that enhance the performance of communal property rights systems:

1. Accurate information about the condition of the resource and the expected flow of benefits and costs is available at low cost to participants. (Blomquist 1992; Gilles and Jamtgaard 1981; Steed 2010)
2. Participants share a common understanding about the potential benefits and risks associated with the continuance of the status quo as contrasted with changes in norms and rules that they could feasibly adopt.
3. Participants share generalized norms of reciprocity and trust that can be used as initial social capital. (Anderson, Locker, and Nugent 2003; Cordell and McKean 1992)
4. The group using the resource is relatively stable. (Berkes 2007; Seabright 1993)
5. Participants plan to live and work in the same area for a long time (and in some cases, expect their offspring to live there as well) and, thus, do not heavily discount the future. (Grima and Berkes 1989)
6. Participants use collective-choice rules that fall between the extremes of unanimity or control by a few (or even a bare majority) and, thus, avoid high transaction or high deprivation costs. (E. Ostrom 1990)
7. Participants can develop relatively accurate and low-cost monitoring and sanctioning arrangements. (Berkes 1992; Van Laerhoven 2010)

In turn, many of these variables are affected by the type of larger regime in which users are embedded. Larger regimes can increase the probability that a community will adopt more effective rules over time when they (these regimes) recognize the legitimacy of common property systems and facilitate local self-organization (McCay 2002). Some of the techniques used by facilitative governments include (1) providing accurate information about natural resource systems; (2) providing arenas in which participants can engage in discovery and conflict-resolution processes; and (3) providing mechanisms to back up local monitoring and sanctioning efforts.

Two additional variables, the small size of a group and its homogeneity, have been noted as conducive to the initial organization of communal resources and to the successful performance of organized users over time (Baland and Platteau 1996; Libecap 1989a; 1989b; E. Ostrom 2009). But neither of these variables is uniformly positive or negative. Changing the size of a group, for example, always involves changing some of the other variables likely to affect the performance of a system. Increasing the size of a group is likely to be associated with at least the following changes: (1) an increase in the transaction costs of reaching agreements; (2) a reduction of the burden borne by each participant for meeting joint costs, such as guarding a system and maintenance; and (3) an increase in the amount of assets held by the group that could be used in times of emergency. Libecap (1995) found that it was particularly hard to get agreements on oil unitization in groups larger than four. Blomquist (1992), on the other hand, documents processes conducted in the shadow of an equity court that involved up to 750 participants agreeing to common rules to allocate rights to withdraw water from groundwater basins in Southern California. The processes took a relatively long period of time, but the water systems have now survived with low administrative costs for half a century (Blomquist and Ostrom 2008). Agrawal (2000) has shown that communal forestry institutions in India that are moderate in size are more likely to reduce

overharvesting than are smaller groups because they tend to invest in a higher level of monitoring by locally hired guards.

The basic causal processes and effects of group heterogeneity are also multifaceted (Agrawal and Gibson 2001; Bardhan and Dayton-Johnson 2002). Groups can differ along many dimensions, including assets, religion, information, valuation of final products, production technologies, landholdings, time horizons, exposure to risk (e.g., headenders versus tailenders on irrigation systems), and cultural belief systems (Keohane and Ostrom 1995; Ray and Bhattacharya 2010; Schlager and Blomquist 1998). Libecap's (1989b) research on inshore fisheries has shown that when fishers have distinctively different production technologies and skills, all potential rules for sharing withdrawal rights have substantial distributional consequences and are the source of conflict that may not easily be overcome.

Libecap and Wiggins's (1984) study of the rationing of crude oil production reveals an interesting relationship between the levels and type of information available to participants and the likelihood of agreement at various stages in a bargaining process. In the early stages of negotiation, all oil producers share a relatively equal level of ignorance about the relative claims that each might be able to make under private property arrangements. Oil-unitization agreements are most likely to be reached successfully at this time. If agreement is not reached early, each participant gains asymmetric information about his own claims as more and more investments are made in private information. Agreements are unlikely at this stage. If producers then aggressively pump from a common oil pool, all tend to be harmed by the overproduction and thus are willing to recognize their joint interests later, after the harm is obvious. Libecap (1995) also shows a strong negative impact of heterogeneity in his study of marketing agreements among orange growers.

The wealth of empirical information on real-existing property systems, only a fraction of which has been recounted here, belies naïve and simplistic theories of property rights that reduce all resource-conservation problems to either too little private-individual ownership or too little public ownership. Unfortunately, such naïve theories, which are usually premised on comparisons of flawed existing institutions with perfect but purely theoretical alternatives (Komesar 1997), continue to dominate the literature. It is high time to move from such simplistic and inaccurate models of property systems to theories that better account for the complexities and contingencies of actual resource governance regimes (rather than idealizations), based on comparative analyses of property institutions operating within larger social-ecological systems. It is hoped that the chapters presented in this volume will make a significant contribution to that effort.

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