

Workshop in Political Theory and Policy Analysis

W90-9

11-22-91
WORKSHOP IN POLITICAL THEORY
AND POLICY ANALYSIS
513 NORTH PARK
INDIANA UNIVERSITY
BLOOMINGTON, INDIANA 47405

ANALYZING THE COMMONS: A FRAMEWORK

by

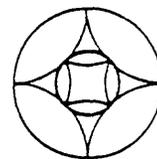
Ronald J. Oakerson
Workshop in Political Theory and Policy Analysis
Indiana University
Bloomington, Indiana

September 6, 1990

Paper to be presented at the first meeting of the International Association for the Study of Common Property, Duke University, September 28-30, 1990.

To appear in Daniel W. Bromley, ed. (1990) Essays on the Commons.
Madison: University of Wisconsin Press, forthcoming.

Indiana University
513 North Park
Bloomington, Indiana 47405-3186



ANALYZING THE COMMONS: A FRAMEWORK

Ronald J. Oakerson¹

My subject can be stated as a riddle: How are forests, fishing grounds, pastures, parks, groundwater supplies, and public highways all alike? Answer: Each one is typically a commons, a natural resource (or a durable facility of human design and construction) that is shared by a community of producers or consumers. The list of shared resources and facilities is both long and diverse. The commons can have a fixed location (a woodlot) or it can occur as a "fugitive" resource (fish and wildlife). The commons can be renewable (grasslands), or not (oil pools). Some cases (oceans, the atmosphere) are indivisible over large areas, so that they cannot feasibly be divided and organized as separate parcels of private property; other cases (small pastures) are organized as commons by social preference. While patterns of organization vary across continents and cultures, the key problem remains the same: how to coordinate use by numerous individuals in order to obtain an optimal rate of production or consumption overall.²

The commons can be distinguished from both public goods and private goods, while sharing some of the attributes of each. Pure public goods can be used by any number of consumers because, like the light from a street lamp, such goods are collectively consumed. Although the street itself can become crowded, the rate of consumption of the lamp-light is independent of the number of consumers and of the particular use individuals make of the good (walking, jogging, motoring, or dancing in the streets). By contrast, private goods are individually consumed--what one individual consumes is either used up or becomes (at least temporarily) unavailable to others.

Like pure public goods, the commons is shared, and unlike private goods, it either cannot be or is not (for any of a number of reasons) divided among separate consumers. Yet like private goods, the use of the commons is characterized by individual consumers who appropriate a portion of the flow of benefits (farmers pump water, cows eat grass) and make that portion unavailable to others (in the case of a resource commons, individuals actually extract private goods from the resource); this means that, unlike pure public goods, the commons cannot be shared without limit.

The commons is like a factory that produces, not a series of differentiated products, but a stream or pool of undifferentiated "product" from which individuals take a portion for their use--hence the term "common pool" resource, preferred by some analysts and equivalent to the commons. Unlike a factory, however, appropriation affects production, or more precisely, the rate at which individuals appropriate affects the rate at which the resource can produce or replenish a supply. Without coordination, individuals may in the aggregate use too much too fast, causing the rate of production to fall. Sharing without collective consumption--the commons situation--requires restraint, which in turn depends on coordination among users. Otherwise, individuals continue to consume without regard to the diminishing marginal product of the commons as a whole.

Even if aggregate use is suboptimal, difficulties are often not noticed until there is some significant change in the pattern and/or level of use, and declining yields begin to reduce the size of the shares available to individuals. If a community of users is unable to work through existing arrangements to respond appropriately to changes,

destructive competition or conflict may follow: Resource depletion (or degradation of facilities) results--the outcome characterized by Hardin (1965) as the "tragedy of the commons." In specific cases, the consequences may be soil erosion, overgrazing, diminishing fish harvests, disappearing species, shrinking forests, or impassable roads.

In this chapter, I present a conceptual framework that can be used to collect information and analyze the commons across a variety of resources and facilities. Such a framework must be specific enough to offer guidance in the field, yet general enough to permit application to widely variable situations. The trick is to develop concepts that identify key attributes shared broadly by the commons in its many manifestations and that can be treated as variables that take on different values from one circumstance to another. This allows a systematic approach to the study of a phenomenon that has great variation. Relationships among variables need to be specified in ways that allow one to diagnose what is wrong and why in particular situations. On such a basis, potential solutions can be offered.

The framework distinguishes four sets of attributes or variables that can be used to describe a commons: (1) the physical attributes of the specific resource or facility and the technology used to appropriate its yield; (2) the decision-making arrangements (organization and rules) that govern relationships among users (and relevant others); (3) the mutual choice of strategies and consequent patterns of interaction among decision makers; and (4) outcomes or consequences (V. Ostrom 1974:55; Oakerson 1981:81). Each set of attributes is related systematically to the others. The plan of discussion is to introduce each of the four types of

attributes, examine the relationships in the framework among the attributes, and, finally, suggest ways of applying the framework both for diagnostic and for prescriptive purposes, as well as for applying it iteratively to understand the impact of technological and institutional change and adaptation.

The framework is no more than a "bare-bones" representation of the commons in its essentials.³ It is intended to identify four types of factors, related in specifiable, limited ways, that can be assumed always to operate with respect to the commons. It should not be construed as a fully specified causal model that includes all relevant variables and relationships in every case. Although not a model into which one can feed data and crank out predictions, the framework is a heuristic tool for thinking through the logic of a situation and considering alternative possibilities. Yet it is a framework that can be elaborated in particular cases to whatever level of complexity and completeness may be desired.

FOUR TYPES OF ATTRIBUTES

Physical and Technical Attributes

Problems of the commons are rooted in constraints given in nature or inherent in available technology. The analytic interest in physical resource properties and technology stems mainly from three considerations: (1) the relative capacity of the resource base to support multiple users at the same time without one interfering with another and without diminishing the aggregate level of benefit (the yield of a resource) available to the group; (2) the degree to which (or relatively ease with which) the commons permits exclusion of individual users, limiting access to the resource or

facility; and (3) the physical boundaries of the commons, determining the minimal scale on which effective coordination can occur. Each of these concerns is addressed below by introducing a relevant economic concept.

Jointness

The concept of jointness was originally introduced to define a "pure public good" (Samuelson 1954). Jointness means that one person's use does not subtract from the use of others. The opposite case is one in which a single individual fully consumes (and destroys) a good. As a variable, jointness refers to degrees of non-subtractability (V. Ostrom and E. Ostrom 1978), that is, the degree to which more than a single consumer can make use of the same good. The idea ordinarily refers to simultaneous use, but can also include serial use. Limits to jointness in the simultaneous use of "impure" public goods are associated with congestion. Once a threshold is crossed, individual users begin to subtract from one another's beneficial use.

The idea of subtractability can be applied to the commons in two ways. First, any user of the commons subtracts from a flow of benefits--what one appropriates, whether gallons of water or blades of grass, is unavailable to others. Second, cumulative use by many individuals will eventually subtract from the total yield of the commons over time--the rate at which a groundwater basin produces water or a pasture produces fodder. It is the second type of subtractability, which reduces the capacity of a resource to generate benefits, that gives rise to the distinctive problem of the commons. In this sense, the commons exhibits partial subtractability, and the threshold at which use becomes subtractive varies from one situation to another. Each individual user is potentially capable of subtracting from

the welfare of other users; but, within limits, all users can derive benefits jointly.

The analysis of a commons, therefore, should specify as precisely as possible the limiting conditions that pertain to natural replenishment or maintenance of the resource. Physical limits established by nature or technology provide critical information for devising rules to maintain jointly beneficial use, such as grazing limits in a common pasture, trapping limits in a lobsterery, and weight limits on a highway. By having reference to such legal rules, it is possible to introduce a modified concept of jointness, so that one person's lawful use does not subtract from the lawful use of others (Oakerson 1981). Thus, resource sharing can be efficient even in the absence of collective consumption (physical non-subtractability), provided that rules based on limiting conditions inherent in the nature of the resource are implemented.

Exclusion

The "exclusion principle," also used by economists to differentiate private goods from public goods (Musgrave 1959), ordinarily refers to the ability of sellers to exclude potential buyers from goods and services unless they pay a stipulated price. The concept can be broadened somewhat to include the question of access to any type of good, including the commons. The opposite of exclusion is complete openness--unlimited access. Although an organized commons need not be characterized by open access (Runge 1981), the commons always has an access-control problem to some degree. As a variable, the degree of exclusion (or access control) attainable depends on both the physical nature of a resource (or design of a facility) and available technology. Historically, for example, open

range was difficult and expensive to fence; but the development of barbed wire to a great extent overcame this limitation.

At this point in the analysis, one is interested not in an exclusion or non-exclusion policy, but rather in excludability, that is, the limiting conditions that apply to the possibility of exclusion as established by nature and/or technology. Two types of exclusion can be distinguished: (1) Access may be fully regulated on an individual basis and/or (2) partially regulated and applied only to those outside the immediate community. This distinction is related to the potential exposure of the commons to increases in demand. Within a definite community of users, increases in aggregate demand derive mainly from expanded operations, but if there is open access, increases in the number of users can also contribute to an increase in total demand on the resource.

Indivisibility

Is the commons divisible? Could the physical resource or facility feasibly be divided among private property holders? What would be the costs of doing so? If the commons is not divisible, what boundary conditions apply to its regulation? On what scale would regulation have to occur to be effective? The relative indivisibility of a commons is mainly a question of scale, determined by specifying the physical boundaries within which the commons cannot be divided without significantly impairing its management potential or production value.

Physical boundaries having to do with divisibility of the resource derive from nature or technology and should not be confused with legal boundaries, that is, boundaries imposed by rule. Consider the example of a groundwater basin. Groundwater occurs in underground aquifers that have

fairly definite physical boundaries. The legal boundaries of a jurisdictional unit formed to deal with a groundwater problem may or may not correspond to the physical boundaries of the resource. Other types of the commons may have less definite physical boundaries; nonetheless, it still may be possible to assign geographic boundaries based on physical or technical attributes. The western range in the United States, for example, might superficially be viewed as a single resource; but variations in weather and soil conditions prompt the "division" or partitioning of the range into much smaller units for management purposes.

An analysis of the commons must posit some set of boundary conditions, even if the physical boundaries are somewhat ambiguous. If the boundaries chosen for the purposes of analysis are too small, then relevant aspects of the problem will be left outside; if the boundaries are too large, then multiple problems may be confounded. Although the precise boundary may be somewhat arbitrary, the relevant question is whether it lies within an acceptable range for the purpose of analysis.

In some cases, the resource is technically divisible into relatively small parcels, and the commons exists by human design alone without reference to natural or technological constraints. Still, there may be underlying economic and/or cultural reasons for the treatment of a divisible resource as a commons. Other parts of the analysis must take cognizance of these reasons as relevant to the design of decision making arrangements, including the possibility of converting the commons to private property. There is nothing in this analytic framework, however, to suggest that divisibility necessarily implies the wisdom of privatization.

Decision-Making Arrangements

The second set of attributes in the framework consists of rules--those rules that structure individual and collective choices with respect to the commons as defined by the first set of attributes. These arrangements may also be thought of as "organizational" or "institutional." The designation used here is intended to convey a very broad set of arrangements that are not confined to any single "organization" or "institution." Bromley (1989) refers to "resource regimes." In such regimes, several discrete institutions and/or organizations are generally implicated in the management or mismanagement of a commons.

In general, decision-making arrangements are defined by authority relationships that specify who decides what in relation to whom. In the discussion below, decision-making arrangements are sorted into three subsets: (1) operational rules that regulate use of the commons; (2) rules that establish conditions of collective choice within the group most immediately involved with the commons; and (3) external arrangements, those decision structures outside the immediate group, that impinge on how the commons is organized and used. Operational rules are nested in collective-choice rules, which are nested in external arrangements. At least three different levels of analysis are possible with respect to the organization of the commons.

Operational Rules

Various types of rules can serve to limit user behavior in the interest of maintaining the yield of the commons. Alternative patterns of use should be evaluated for the degree to which each subtracts from the flow of the resource. Some uses have the potential to drive other uses out

and/or quickly exhaust the resource. Such highly subtractive behavior may therefore be disallowed. Less subtractive patterns of use can also, cumulatively, diminish the yield of the commons. Limits may therefore be imposed on both duration and type of use, as well as the amount of the resource-flow that can be appropriated during a time period. If more than one use is made of a commons, operational rules need to take into account the relationships among uses. Some types of use may be compatible; others, sharply conflicting. At times a commons is physically partitioned for different uses without dividing it into separate parcels of property; the effect is to segregate users, while retaining joint use. Use can also be time-partitioned, reflecting conditions of seasonality or potential congestion.

Conditions of Collective Choice

Operational rules derive from collective choices that are also rule-ordered. Rules that establish conditions of collective choice to allow a group of appropriators to manage their commons can be understood as a "common property" arrangement. Individuals are no longer entirely free to decide for themselves how to make use of the commons, as in a private property arrangement, but participate in a process of collective choice that sets limits on individual use. In one degree or another, the rights of individual ownership give way to rights of common ownership. Common property arrangements protect individual shares in the yield of the commons, and thus provide an institutional foundation for protecting the total yield of the commons as well.

Four different relationships affect the conditions of collective choice: (1) the capacity of individuals to make decisions solely on the

basis of personal discretion in matters of concern to others, perhaps preempting action by others or initiating an action that creates costs of opposition for others; (2) the availability of potential sources of remedy to individuals adversely affected by others; (3) the capacity of an affected population to relax the market rule of willing consent and make a collective decision binding on all relevant individuals; and (4) the presence of potential veto positions in any process of collective decision making--opportunities for any one individual or group to say "no."

This portion of the analysis addresses a series of questions: Is coordination purely voluntary? If not, what proportion of the community must agree before a course of action may be adopted? If adopted, is the course of action enforceable? How are enforcement actions undertaken? In what forum can disputes be settled and on what legal grounds? To what extent are collective choice and enforcement dependent on the exercise of authority by more inclusive units of government? Are these more inclusive units local, regional, and/or national?

In a common property arrangement, a limited set of individuals have use-rights, but ownership is in some sense vested in the group, which thus acquires the power to regulate the commons and to exclude others.⁴ Entry and exit rules (E. Ostrom 1986) are concerned with exclusion and seek to regulate access to the commons. In a broad sense, this set of rules includes qualifications for participation in a community of users (entry) and whether membership in an organization of users is compulsory (exit), and thus affects conditions of collective choice. Boundary rules, closely related to entry and exit rules, determine the legal domain of a collective decision-making arrangement. Any organizational arrangement for governing

a commons must stipulate a set of jurisdictional boundaries. These boundary rules, however, may or may not be congruent with the underlying boundary conditions determined by the technical and/or physical nature of the resource.

A number of variations in common property arrangements can be found. Depending on the particular arrangement and its relationship with more inclusive legal arrangements in the larger community, common property may or may not include the ability to transfer ownership to others and thus derive a joint return on investment. Alternatively, individuals may have private rights to make use of the commons, and thus to exclude others, but not have the power as a group to regulate the commons, except on the basis of willing consent. Such individuals may, however, be vested with rights that protect them from injury caused by others' use of the commons. Remedies may be available through such "third-party" arrangements as courts. Another possibility is the creation of some form of collective organization in addition to private property rights that endows the group with regulatory authority. This is another way of allowing a community of users to make collective choices, without the willing consent of each party, that establish limits on individual use. Common property arrangements should be distinguished from general public or government ownership that vests control of the commons in government agencies, rather than in the communities directly affected.

External Arrangements

Decision-making arrangements external to the community are also relevant in most cases, but the connection varies widely. Some external arrangements may be mainly constitutional, establishing the capability of

the community of users to engage in local collective choice. For example, the State of California has enacted enabling legislation that allows private property owners to form special districts to manage groundwater supplies. At the other extreme, a community may be substantially dependent on external decision makers for the legislation and enforcement of operational rules, replacing common property arrangements with control by external officers. In this case, external arrangements are bureaucratic in nature, characterized by some combination of central rule making and field officer discretion. In addition, third-party arrangements may also be available externally to resolve disputes between users. Courts of law fall into this category, but so do such other arrangements as a bureaucratic hearing officer or a traditional local chief in areas with a tribal history. Finally, market arrangements external to the commons may be relevant in establishing economic parameters within which management of the commons can be undertaken. If there were no market in land, for example, those who use common land for grazing or agriculture would be affected differently than if land were also available on the private market.

Patterns of Interaction

Rules, as everyone is aware, do not guarantee the emergence of a particular pattern of behavior. Between rules and observed behaviors lie the unobserved mental calculations of individuals who make choices. Individuals choose strategies for relating to one another and to the commons. Patterns of interaction result directly from the mutual choice of strategies by the members of a group. Given the physical features of the commons and characteristics of the relevant technology as well as the

decision-making arrangements available to govern its use, individuals make choices, from which there emerges some pattern of interaction.

Although individual choices can be understood in terms of a comparison of the costs and benefits of alternative actions, these economic concepts remain abstract until related to the particular circumstances of individuals. As experienced by individuals, a "cost" is any perceived obstacle to the choice of some alternative (Buchanan 1969). Conversely, a "benefit" is any perceived inducement to choose one alternative over another. Individual choices are conditioned by a mental image of obstacles and inducements in a relevant environment. The resulting incentives to act or not to act in various ways may be relatively strong or weak.

Important elements of individual behavior on the commons are interdependent (Runge 1981). How others are expected to behave creates obstacles and inducements for each individual. Several possible strategies are of interest. One is a freerider strategy. When others propose a course of action, an individual says, "You go ahead, but I'm not interested." If the others do go ahead, the freerider strategy is successful, at least in the short run. Whether a single freerider can undermine a collective effort depends on the subtractiveness of that individual's use of the commons. Alternatively, an individual may choose a cooperative strategy, continuing to contribute to a joint undertaking as long as others also continue. The mutual choice of cooperative strategies leads to a general pattern of reciprocity.

Reciprocity among group members has an interesting structure. Individuals contribute (through mutual action or mutual forbearance) to one

other's welfare, but without an immediate quid pro quo as in exchange relationships (Oakerson 1988; Boulding 1972). On the commons, an individual must practice restraint when the beneficiaries of his or her restraint consist mainly of others. At the same time, each individual draws the larger benefit, not from his or her own act of restraint, but from the restraint practiced by others. Individuals can agree to a pattern of mutual restraint, and mutually enforce such a pattern, but they cannot trade one act of restraint for another the way that individuals exchange commodities. The quid pro quo that regulates an exchange relationship is unavailable to regulate reciprocity. Yet, only through a pattern of reciprocity can individuals realize the joint benefit of mutual restraint. Instead of a quid pro quo, reciprocity depends on mutual expectations of future positive performance. While exchange is based on ex ante conditions (i.e., an exchange does not occur until certain conditions are met on both sides), reciprocity is subject to ex post conditions (i.e., conditions that are met following one's contribution to a joint undertaking) as individuals learn what to expect from one another. What is ordinarily called "collective action" can be understood as n-person reciprocity--the reciprocal interaction of individuals who jointly contribute to a common effort.

Free-riding behavior erodes reciprocity. Initially, one individual may choose not to contribute with the expectation that others will continue as before. The prospect of "riding free" on the contributions of others can be a substantial inducement, but an even stronger obstacle to the choice of a cooperative strategy is a lack of assurance (see Runge, this volume) that others will do likewise. The organizational challenge is to

sustain mutual choices of cooperative strategies among a sufficient number to sustain the yield of the commons.

Collective decision-making arrangements are designed to alter the structure of obstacles and inducements that individuals otherwise would face. However, any assignment of decision-making capabilities simply sets parameters within which individuals choose strategies. While cooperation and noncooperation among users are the first-order strategies of interest, there are also second-order strategies that affect first-order choices. Within the community of users, for example, successful collective action may depend on the degree to which individuals are willing and able to monitor one another's behavior in order to hold each other accountable to shared standards of conduct. If decision-making arrangements provide for the enforcement of rules and application of sanctions, then the choice of enforcement strategies by officials is often critical. A variety of decision makers, from bureaucrats to judges, may play a role.

If reciprocity erodes, and is ultimately abandoned, mutually destructive competition and/or conflict follows. Users of the commons may try to drive one another out to preclude mutually subtractive use. Or they may engage in a competitive race to exploit the commons without regard to an optimal rate of use. At this stage, the relevant second-order strategies may include concealment, deceit, intimidation, threats, and violence. Range wars observed in the settlement of the western United States are illustrative.

Outcomes

Patterns of interaction produce physical outcomes subject to human

evaluation. To supply information for this fourth set of attributes in the framework, the analyst is required to (1) stipulate the use of evaluative criteria and (2) search for consequences that affect users of the commons (and others involved) in accordance with these criteria. The study of consequences is necessarily value laden. To distinguish relevant consequences, the analyst must draw on evaluative criteria, such as, most commonly, conceptions of efficiency and equity. But these abstractions have to be converted into operational measures of value in order to be used to appraise specific outcomes.

Considerations of efficiency in the use of commons have to do with the overall rate of use. Technical and physical attributes of the commons indicate some optimal rate. Aggregate over-use, such as placing too many animals on a common pasture or withdrawing too much water from a groundwater basin, eventually reduces the total yield, leaving each user with a smaller share. Accelerating over-use can lead to resource depletion or facility destruction, leaving everyone with a zero share. Inefficiency is also present, however, if the resource or facility is under-utilized: a closed commons can be inefficient, just as an open commons. A plan of regulation should be evaluated in terms of the value of uses foregone compared to the value of uses retained.

To conclude that there is inefficiency in the use of the commons, in principle one can use the test of Pareto optimality: If at least one person could be made better off, and no one worse off, by a modification in the use of the commons, then present outcomes are inefficient; conversely, the proposed change is efficient. Often, however, it is not possible to do the precise technical and economic calculations necessary to determine

whether aggregate use of the commons is optimal (i.e., whether no further improvement is possible). Less information is needed to determine whether the current resource yield is being maintained with a given level of effort in extraction than whether the current yield could be economically increased. Furthermore, some degree of suboptimal use may actually be efficient when the costs of obtaining collective action are taken into account. An emphasis can be placed on identifying Pareto-efficient changes, that is, improvements in efficiency, rather than on identifying a Pareto-optimal condition from which no further improvement is possible. Information requirements--and perhaps the costs of obtaining collective action--are somewhat reduced by seeking amelioration rather than optimization per se.

Inefficiency on the commons is apt to be closely associated with inequity. The basic equity issue is distributive, but not redistributive: Do individuals get a reasonable and fair return on their contribution to a collective undertaking that regulates behavior? The presence of inequities may lead to the collapse of reciprocity, resulting in less efficient use. Equity problems are apt to be aggravated by asymmetries among users, which create opportunities for some to benefit at others' expense. This, in turn, can lead to costly conflict where all parties lose. Such situations may still admit of Pareto-efficient change. In any event, Pareto-efficient changes satisfy a minimal standard of fairness: They do no harm. Measuring equity, however, is even more difficult than measuring efficiency, often compelling a reliance on rough-and-ready indicators, such as whether most members of the commons community seem to be relatively satisfied with existing arrangements. Other questions that arise from

considerations of equity include the possibility of arbitrary exclusion from the commons or selective enforcement of rules. Abuse of authority and/or corruption may also contribute to inequities.

RELATIONSHIPS

All instances of the commons have characteristics that can be sorted among the four types of attributes considered above: (1) physical attributes and technology, (2) decision-making arrangements, (3) patterns of interaction, and (4) outcomes. The purpose of dissecting the commons in this manner is to examine relationships among the four bundles of variables. Having collected and sorted the data, these relationships become the principal focus of study.

Figure 1 depicts the framework, showing how each set of attributes relates to the others. Both the physical and technological attributes of the commons and decision-making arrangements affect patterns of interaction, which combine with physical and technological attributes to produce outcomes. Solid lines (a) and (b) represent weak causal connections, weak in the sense that individual behavior is constrained, but not determined, by either the physical world or by rules. Solid lines (c) and (d) represent stronger causal relationships because human discretion is not involved as a dependent variable.

[Figure 1 About Here]

The technical and physical characteristics of the commons affect outcomes in two ways. One path leads through patterns of interaction. The

other affects outcomes directly, independent of human choice. Physical and technological attributes are "hard" constraints. If ignored in the process of choice, physical/technical constraints still affect outcomes.

Decision-making arrangements, on the other hand, have no effect on outcomes independently of human choice and interaction. Institutions are "soft" constraints, made operative only through human knowledge, choice, and action. Rules exist in the realm of language, whether written or unwritten. Decision-making arrangements, therefore, need to be comprehended as commonly understood and applied by the relevant community of decision makers.

A good example that highlights the way in which the physical nature of a resource affects individual strategies and social interaction is found in the case of Maine inshore lobster fisheries (Acheson 1975; Wilson 1977). Unlike schooling fish, the sedentary lobster inhabits small inshore areas. Thus, the fishing area is easily accessible and can be monitored daily by the community of fishermen. Lobster traps are marked by each fisherman in distinctive colors, so small communities of fishermen can define and monitor exclusive fishing areas. Fishermen from outside the community may lose their gear, but within the community mutual forbearance allows "locals" to leave their gear safely. This pattern of interaction allows the community to control access to the commons. Decision-making arrangements within the community are entirely voluntary. Those outside the community have no effective recourse to gain access. The physical nature of the resource sets the relatively small set of boundaries that defines each inshore area and makes it possible to exclude individual fishermen. Joint use is feasible as long as fishermen are willing to act

with mutual forbearance.

The use of public roads for hauling coal from mine to rail in Eastern Kentucky (Oakerson 1981) provides an example that highlights how the distribution of decision-making capabilities between local officials and (in this case) state officials can affect the mutual choice of strategies. Although usually considered public goods when they are publicly provided, roads have the characteristics of the commons once provision has been made. Organizing the joint use and maintenance of roads is like organizing the use of a ground water supply or any other commons. In the case of roads, excessive use includes hauling loads that exceed the weight-bearing capacity of the road surface and base. Rural highway development, provision, and maintenance in Kentucky is largely a state government responsibility; but the application of criminal sanctions against violators of state-prescribed weight limits is in the hands of locally elected judges in each county. Local judges have allowed coal haulers and mine operators to sustain non-compliant, free-rider strategies, hauling loads that often destroy state highways. State highway-department efforts to induce cooperation from local judges by withholding maintenance from all Eastern Kentucky coal-field highways proved not to be a politically feasible strategy because ordinary users were affected jointly with coal haulers. State highway officials, nevertheless, were able to reduce maintenance efforts on selected coal-haul routes as an economy measure. This strategy sometimes induced limited maintenance of public roads by mine operators, but did not affect the basic choice of strategy by coal haulers to carry overweight loads. The overall result was a system of public coal-haul roads subject to a combination of over-use and under-maintenance.

To use the framework as a diagnostic tool, an analyst works backward through the relationships. Initial inquiry focuses on outcomes: What is happening to the commons and to its community of users? Are individuals investing more and obtaining less from the commons? Are yields declining as effort is increasing? If so, the next question is--why? A first-order answer can be obtained by examining patterns of interaction among resource users. Are members of the community competing with one another to maximize their individual "take" from the commons? Are there asymmetries among users that allow some to "raid" the resource and then move on? The inquiry cannot stop, however, with patterns of interaction. The question, "why," recurs. Second-order answers depend on how physical and technical properties of the commons together with decision-making arrangements jointly affect patterns of interaction. What constraints and opportunities are inherent in the physical nature of the resource and the technology available to appropriate its yield? What opportunities do the operational rules attempt to foreclose? What are the incentives of users to comply with, and of officials to enforce, operational rules? Do collective-choice rules allow the consideration of alternative operational rules? Do external arrangements allow for modifying the rules that define conditions of collective choice?

Outcomes disclose the effect of a difficulty that is manifest behaviorally in patterns of interaction. The source of the difficulty, however, lies in a lack of congruence between the first two sets of attributes--a mismatch between the technical and physical nature of a commons and the decision-making arrangements used to govern its use. This is the relationship labeled (e) in Figure 1. The dashed line is used to

represent a non-causal association that exists, if at all, by human design. The lack of a good "fit" between these two elements in the framework potentially creates a perverse structure of incentives--obstacles and inducements--leading individuals into counterproductive patterns of interaction that generate undesirable outcomes.

Incongruence between the first two sets of attributes--between the physical world and the institutional world--may first be apparent in a lack of fit between operational rules and corresponding technical and physical attributes of the commons. Use-rules should closely match the limiting conditions that bear on maintaining the yield of the commons; entry and exit rules must be related to the limiting conditions of exclusion (excludability); boundary rules ought to reflect those limiting conditions that bear on the appropriate geographic domain of regulation. If efforts to adapt operational rules to technical and physical attributes have failed, and there is a general understanding in the relevant community of the relationships between attributes of the commons and specific operational rules, the problem may lie with the rules that define conditions of collective choice. Further, if efforts to adjust the conditions of collective choice in the community have failed, the difficulty may lie with external arrangements.

Having diagnosed problematic conditions by working backward through the framework, one can turn to questions of design: how to modify patterns of interaction by adjusting decision-making arrangements to better fit the particular nature of the commons. Design requires an analyst to work, prospectively, forward through the framework. What do key features of the technical and physical attributes require of operational rules and

conditions of collective choice? What adjustments might be made in external decision-making arrangements? How would these institutional changes affect the structure of incentives that face decision makers? What choice of strategies, and resultant patterns of interaction, would the analyst anticipate? How would anticipated patterns of interaction affect users of the commons and others?

DYNAMIC APPLICATIONS

In the short-run analysis undertaken for a diagnostic purpose, both the physical/technical attributes of the commons and decision-making arrangements are assumed to be unchanging. A prescriptive or long-run analysis, however, must allow for change in both sets of variables. One way to introduce a longer time horizon into the analysis is to apply the framework iteratively. The framework is used to record and describe changes at successive points in time. This approach treats institutional change as exogenous; the aim is simply to understand how a series of changes in technology and/or decision-making arrangements affect patterns of interaction and outcomes. Viewing change as exogenous, however, does not help to explain how change comes about. The effort to understand institutional change raises new issues. What incentives promote investment in technology? What opportunities are present for learning the consequences of actions?

[Figure 2 about here]

In order to aid in understanding institutional change, the framework

can be modified by adding a set of long-term relationships, shown by the broken lines in Figure 2.⁵ Outcomes can affect patterns of interaction insofar as a process of learning occurs, causing individuals to modify their strategies. Instead of continuing to produce outcomes on the basis of decision-making arrangements as given, individuals may attempt to modify those arrangements to produce better outcomes. Similarly, individuals may invest in technological innovation that would change the technical and physical attributes of the commons. The latter may also change over time as an indirect result of strategies pursued in securing outcomes; this is easily seen if prevailing patterns of interaction result eventually in the destruction of a resource.

CONCLUSION

The purpose of the framework presented here is to aid in the collection and assimilation of case-by-case analyses. The ability to observe regularities across many different cases depends on the use of a consistent framework. Some method is needed to array information into meaningful sets in order to examine relevant relationships in a particular case. Use of a consistent method by a community of scholars enhances the comparability of separate case studies. As scholars use and apply a framework, and share ideas, the framework, too, becomes the subject of change--elaboration or modification--in view of experience.

This volume is a first step in that direction. The framework was adopted by the Panel on Common Property Resource Management, organized by the Board on Science and Technology for International Development (BOSTID) at the National Research Council, and used to organize the presentation of 20 case studies at an international conference held at Annapolis, Maryland,

in 1985 (National Research Council 1986): The cases in the present volume, selected from those presented at the Annapolis conference, represent applications of the framework from which one might learn something about its limits and possibilities, as well as something about the commons. Others have used the framework, or a related version, in studies undertaken since Annapolis (Blaikie and Brookfield 1987; Tang 1989).

A great deal more work remains to be done. It is important that the collection of cases begun in Annapolis go forward in ways that permit systematic comparisons. There is much more to be learned about the varieties of collective decision-making arrangements, or resource-regimes, developed by communities that depend on the commons in one or another form, and, especially, about how these arrangements are nested within the larger set of social and political arrangements found in all societies. The continued success of communities in governing and managing their commons, not to mention an ability to convert failures to successes, is dependent on the knowledge-base we can build.

ENDNOTES

1. I would like to thank fellow members of the Panel on Common Property Resource Management, National Research Council, as well as the other participants in the Annapolis Conference, for the many rounds of discussion and criticism--and editorial work--that contributed to the development and application of the framework presented in this chapter. The conference and its resultant volumes have been products of an extraordinary team effort from start to finish. I am also grateful to Robert Netting, Vincent Ostrom, and Susan Wynne for their helpful comments on one or more drafts. For remaining imperfections, I am fully responsible.

2. It is important to keep distinct the natural production process of the resource system and the production process in which individual users of the commons may be engaged. The product or yield of the commons--grass, water, timber--is often used as a factor in the production of a commodity--milk, electric power, lumber. The commodity producers are resource consumers. Sometimes production occurs actually on the commons (rangelands); sometimes not (groundwater).

3. The generic framework, without specific application to the commons, has been developed in a more elaborate way by Larry Kiser and Elinor Ostrom (1982).

4. Hardin's "tragedy of the commons" (1968) occurs in a context of unrestricted access, and thus may or may not apply to a commons, but does not in general apply to a common property arrangement.

5. Subsequent to the Annapolis Conference, I have concluded that a multi-level framework is a better way to represent dynamic relationships, as opposed to the recursive framework shown in Figure 2. At least three levels of analysis are needed. An operational level of analysis views operational rules as the relevant decision-making arrangements, considers interactions among resource users, and evaluates welfare outcomes. This level is nested within a second level of analysis that treats operational rules as an intermediate outcome and collective-choice rules as the relevant decision-making arrangement. Both levels are nested within a third level, this one treating collective-choice rules as an intermediate outcome, and more inclusive or external institutions as relevant decision-making arrangements. Institutional change at one level is an outcome of patterns of interaction at another level. For a related discussion, see Kiser and Ostrom (1982).

REFERENCES

- Acheson, J. M. 1975. The Lobster Fiefs: Economic and Ecological Effects of Territoriality in the Maine Lobster Industry. Human Ecology 3: 183-207.
- Blaikie, Piers and Harold Brookfield. 1987. Common Property Resources and Degradation Worldwide. In Blaikie and Brookfield (eds.), Land Degradation and Society: 186-195. London and New York: Methuen.
- Boulding, Kenneth E. 1972. The household as Achilles' heel. Journal of Consumer Affairs 6:111-119.
- Bromley, Daniel W. 1989. Property Relations and Economic Development: The Other Land Reform. World Development 17 (no. 6): 867-877.
- Buchanan, James M. 1969. Cost and Choice. Chicago: Markham.
- Hardin, Garrett. 1968. The tragedy of the commons. Science 162: 1243-1245.
- Kiser, Larry L. and Elinor Ostrom. 1982. The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches. In Elinor Ostrom (ed.), Strategies of Political Inquiry. Beverly Hills: Sage.
- Musgrave, Richard A. 1959. The Theory of Public Finance: A Study in Public Economy. New York: McGraw-Hill.
- National Research Council. 1986. Proceedings of the Conference on Common Property Resource Management. Washington, D.C.: National Academy Press.
- Oakerson, Ronald J. 1981. Erosion of public goods: the case of coal-haul roads in eastern Kentucky. In Crecine, John P., ed., Research in Public Policy Analysis and Management, vol. 2, 73-102. Greenwich, Connecticut: JAI press.

- Oakerson, Ronald J. 1988. Reciprocity: A Bottom-Up View of Political Development. In Vincent Ostrom, David Feeny, and Hartmut Picht, Rethinking Institutional Analysis and Development: Issues, Alternatives, and Choices, pp. 141-158. San Francisco: ICS Press.
- Ostrom, Elinor. 1986. An Agenda for the Study of Institutions. Public Choice 48: 3-25.
- Ostrom, Vincent. 1974. The Intellectual Crisis in American public Administration. Rev. ed. University, Alabama: University of Alabama Press.
- Ostrom, Vincent and Elinor Ostrom. 1978. Public goods and public choices. In Savas, E.S. (ed.), Alternatives for Delivering Public Services, 7-49. Boulder, Colorado: Westview Press.
- Runge, C. Ford. 1981. Common property externalities: isolation, assurance, and resource depletion in a traditional grazing context. American Journal of Agricultural Economics 63: 595-606.
- Samuelson, Paul A. 1954. The pure theory of public expenditure. Review of Economics and Statistics 36: 357-359.
- Tang, Shui Yan. 1989. Institutions and Collective Action in Irrigation Systems. Ph.D. Dissertation, Indiana University.
- Wilson, James A. 1977. A test of the tragedy of the commons. In Hardin, Garrett, and John Baden (eds.), Managing the Commons, 96-111. San Francisco: W.H. Freeman.

FIGURE 1: A Framework for Analyzing the Commons

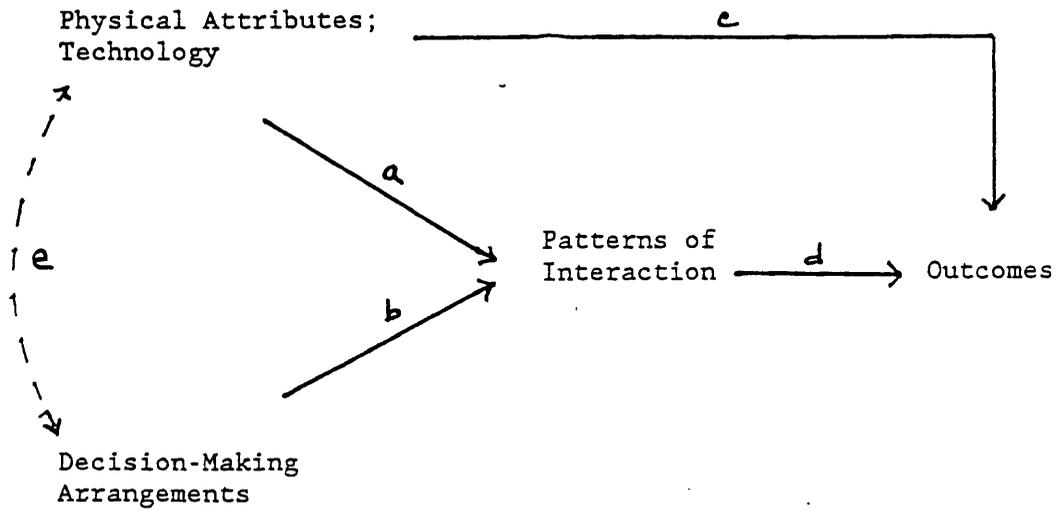


FIGURE 2: A Dynamic Framework

