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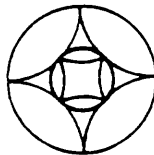
INSTITUTIONAL ARRANGEMENTS
AND THE COMMONS DILEMMA

by

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The Commons Dilemma

Since Garrett Hardin's captivating article in *Science* (December 1968), the expression, "the tragedy of the commons," has come to symbolize the degradation of the environment that is to be expected whenever many individuals use a scarce resource in common. Kenneth Godwin and W. Bruce Shepard (1979: 265) refer to Hardin's article as "the dominant framework within which social scientists portray environmental and resource issues." To illustrate the logical structure of his theory, Hardin asks the reader to envision a pasture "open to all." He then examines the structure of this situation from the perspective of a rational herdsman. Each herdsman receives a

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direct benefit from his own animals and suffers delayed costs from the deterioration of the commons when he and others overgraze. The herdsman is motivated to add more and more animals because he receives the direct benefit of his own animals and bears only a share of the costs resulting from overgrazing. Hardin concludes:

Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. (Hardin, 1968: 1244)

Hardin was not the first to notice the tragedy of the commons. Aristotle had long ago observed that “what is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest” (*Politics* 2.3, Jowett’s translation). Over 150 years ago, William Forster Lloyd ([1833] 1977) sketched a theory that predicted improvident use for property owned in common. More than a decade before Hardin’s article, H. Scott Gordon, in “The Economic Theory of a Common-Property Resource: The Fishery” (1954), clearly expounded what has become a classic on its own.

If the only “commons” of importance were a few grazing areas or fisheries, the “tragedy of the commons” would be of little general interest. This is not the case. Hardin himself used the grazing commons as a metaphor for the general problem of overpopulation. The tragedy of the commons has been used to describe such diverse problems as the Sahelian famine of the 1970s (Picardi and Seifert, 1977), the problem of acid rain (R. Wilson, 1985), the organization of the Mormon Church (Bullock and Baden, 1977), the inability of the U.S. Congress to limit its own capacities to overspend (Shepsle and Weingast, 1984), urban crime (Neher, 1978), public sector-private sector relationships in modern economies (Scharpf, 1985), the problems of international cooperation (Snidal, 1985), and communal conflict in Cyprus (Lumsden, 1973).¹

Analytically, Hardin’s theory has been formalized as an *N*-Person, Commons Dilemma Game (Dawes, 1973, 1975). When the stark features of the formal representation are examined, the decision

facing the herdsman in an open-access commons has the same underlying structure as the decision facing each prisoner in the Prisoner’s Dilemma (PD) game.² For each of the players in this dilemma, the “don’t cooperate” strategy strictly dominates the “cooperate” strategy. The equilibrium resulting from each player selecting his “best” individual strategy is, however, not the best joint outcome. Each player seeking to obtain the best result (the temptation payoff) and to avoid the worst result (the sucker’s payoff) ends up with a third-rate outcome.

The normal form to represent the structure of a PD game is

| | | PLAYER 2 | |
|----------|-----------------|---------------------------------------|---------------------------------------|
| | | Cooperate | Don’t cooperate |
| PLAYER 1 | Cooperate | Second-best result for both | Worst result for 1, best result for 2 |
| | Don’t cooperate | Best result for 1, worst result for 2 | Third-best result for both |

The Prisoner’s Dilemma game has fascinated many scholars. The paradox that individually rational strategies lead to collectively irrational outcomes seems to challenge a fundamental faith that rational human beings can achieve rational results. In the introduction to his *Paradoxes of Rationality and Cooperation*, Richmond Campbell explains the “deep attraction” of the dilemma.

Quite simply, these paradoxes cast in doubt our understanding of rationality and, in the case of the Prisoner’s Dilemma, suggest that it is impossible for rational creatures to cooperate. Thus, they bear directly on fundamental issues in ethics and political philosophy and threaten the foundations of the social sciences. It is the scope of these consequences that explains why these paradoxes have drawn so much attention and why they command a central place in philosophical discussion. (Campbell, 1985: 3)

The deep attraction of the dilemma is also illustrated by the number of articles written about it. At latest count—over a decade ago—more than two thousand papers had been devoted to the Prisoner's Dilemma game (Grofman and Pool, 1975).

When the game is viewed as a situation that will be repeated for a predetermined number of rounds known to all participants, most theorists predict that players will select their dominant strategy in each round so that there is a deficient equilibrium in each and every game in the series of games. Several predictions are made for an iterated Commons Dilemma game when the number of iterations is unknown to the players. Some theorists still argue that a rational player should play the "don't cooperate" strategy in every round (see, for example, Sobel, 1985). Others argue that rational players facing one another for an unknown number of plays could use contingent strategies to "teach" one another the benefits of selecting cooperative strategies (see, for example, Braybrooke, 1985; R. Hardin, 1982), or Bayesian estimates of subjective probabilities to resolve the dilemma (see J. Wilson, 1986; Aumann, 1987). Still other models assume that resolute players can use strong threats of permanent retaliation, instead of cooperative moves and forgiveness, to develop models of repetitious games that predict the selection of cooperative strategies by all (see Levhari and Mirman, 1980; Lewis and Cowens, 1983; Cave, 1984; Bendor and Mookherjee, 1985). Taking an evolutionary approach, Robert Axelrod (1981, 1984) has analyzed strategies that may be collectively stable under varying conditions of long-term play, and Ulrich Witt (1986) has examined how frequency-dependent learning may help avoid a deficient equilibrium. In a review of the literature on multiagent exploitation of fishery resources, Veijo Kaitala (1986) describes the wide diversity of predicted equilibria in recent game-theory models of commons situations.

With few exceptions (R. Hardin, 1982; Braybrooke, 1985; Orbell and Wilson, 1978), analyses of the Commons Dilemma have focused on the structure of the game as given.³ From within the game, participants are trapped in an eternal struggle of tragic proportions. Even when analysts have examined situations that

would extend for infinite periods of time, the presumption is usually made that the participants themselves have no control over the structure of the situation in which they find themselves.⁴ The prisoners in the story upon which the PD game is based were indeed trapped. The physical constraints of separate cells in a prison and a resolute prosecuting attorney imposed an immutable structure upon them. Is this immutability a temporary conceptual and methodological constraint or a deeper substantive necessity? I shall argue that the structure is conceptually and methodologically necessary for analysis, but not an empirical necessity. The inability of participants to change the structure may be a feature of empirical reality in some situations; however, it is not characteristic of all situations.

All analysis is based on assumptions that keep some conditions constant and allow others to vary. Without considering some variables as exogenous to the situation under analysis, it is not possible to analyze that situation. Taking the structure of a Commons or Prisoner's Dilemma as given allows the analyst to derive the likely results that would occur if individuals were to find themselves in a situation that meets the conditions of the model. In the ongoing, complex, multilevel world of action, what is exogenous at one level of analysis may be endogenous at another.⁵ Fixation on the rigidity of analytical constraints has had unfortunate consequences when prescriptions are based on this view. The grim predictions generated by many analysts about the Commons Dilemma has led to policy recommendations of an equally grim character. William Ophuls (1973: 228) has, for example, argued that "because of the tragedy of the commons, environmental problems cannot be solved through cooperation . . . and the rationale for government with major coercive powers is overwhelming." Ophuls concludes that "even if we avoid the tragedy of the commons, it will only be by recourse to the tragic necessity of Leviathan" (p. 229).

Garrett Hardin himself argued a decade after his earlier article that we are enveloped in a "cloud of ignorance" about "the true nature of the fundamental political systems and the effect of each on the preservation of the environment" (1978: 310). The "cloud of ignorance" did not, however, prevent him from presuming that the

only alternatives to the Commons Dilemma are what he calls "a private enterprise system" on the one hand or "socialism" on the other (p. 314). With the assurance of someone convinced that "the alternative of the commons is too horrifying to contemplate" (1968: 1247), Hardin indicates that change must be instituted and with "whatever force may be required to make the change stick" (1978: 314). In other words, "if ruin is to be avoided in a crowded world, people must be responsive to a coercive force outside their individual psyches, a 'Leviathan,' to use Hobbes's term" (p. 314).

The presumption that Leviathan is necessary to avoid tragedies of the commons leads to recommendations of central government control of most natural resource systems. Robert L. Heilbroner (1974) has opined that "iron governments," perhaps military governments, are necessary to achieve control over ecological problems. In a less draconian view, David W. Ehrenfeld (1972: 322) suggests that if "private interests cannot be expected to protect the public domain then external regulation by public agencies, governments, or international authorities is needed" (see also Carruthers and Stoner, 1981). Peter Stillman (1975: 13) points out that those who see "a strong central government or a strong ruler" as a solution, implicitly assume that "the ruler will be a wise and ecologically aware altruist" even though these same theorists presume that the users of common-pool resources will be myopic, self-interested, and ecologically unaware hedonists.⁶

In contrast, other analysts call, in equally strong terms, for the imposition of private property rights whenever resources are owned communally (Demsetz, 1967; Welch, 1983). "Both the economic analysis of common property resources and Hardin's treatment of the tragedy of the commons" leads Robert J. Smith (1981: 467) to suggest that "*the only way to avoid the tragedy of the commons in natural resources and wildlife is to end the common-property system by creating a system of private property rights*" (my emphasis).

I have no quarrel with the argument that dividing a commons and assigning individual property rights enhances efficiency in many situations (see, for example, Feeny, 1982). Similarly, I have no quarrel with the argument that administering some resources through

central-government authority may avoid the tragedy of overuse in other situations. I do take issue with the presumption that either central-government administration or private-property rights is "the only way to avoid the tragedy of the commons." Limiting institutional prescriptions to either "the market" or "the state" would mean that the social-scientific "medicine cabinet" contained only two remedies.

Tools exist to analyze far more complicated situations than the simple game that is used repeatedly to "illustrate" the Commons Situation. Those prescribing simple solutions have allowed themselves to be "hung up" on simple, one-level, paradoxical situations.⁷ Immense scholarly energy has been devoted to trying to prove that individual rationality in a perverse situation will somehow avoid an irrational outcome. Why should we expect perfectly rational individuals placed in highly irrational structures, with no opportunity to change the structure, to achieve collective rationality? There is no more irrational way to structure any enduring situation than that represented by the PD game: no communication among the participants, no previous ties among them, no anticipation of future interactions, and no capacity to promise, threaten, or cajole.

Would reasonable humans, trying to order their own long-term relationships in a productive manner, structure a situation in such a perverse way? Reasonable humans may, of course, structure situations in this manner when they wish to *prevent* the participants in a situation from cooperating with one another. Some cooperation among participants may lead to harms externalized on others, as in criminal conspiracies or economic cartels. Cooperation is not an unambiguous good in all situations (see Ullmann-Margalit, 1977). Is the only "choice" available to rational human beings a "choice" within the constraints of an externally imposed structure? Once we accept this limited view of choice, we are doomed to accept the imposition of structure by external authorities as the only way out of perverse situations such as the Commons Dilemma. I do not accept such a limited view of choice; I now turn from this critique to a more positive approach to the study of Commons Dilemmas.

In the next section I will briefly describe four commons situations that have not resulted in tragedy. If we are to understand how individuals can escape from tragedy, we need to study "success stories" carefully. These stories are particularly interesting because none of them relies on central control or market mechanisms as its primary mode of management. Empirical cases provide the grist for further theoretical development. Once I have presented these four cases, then, I will turn to several substantive and methodological lessons to be learned from analysis of them.

Successful Efforts to Cope with the Commons

West Basin, California. Given the arid conditions of Southern California, the development and use of water resources has been crucial to the growth of that area during the twentieth century. Luckily, metropolitan Los Angeles happens to overlie a complex set of interrelated groundwater basins. In addition to the construction of several major aqueducts to bring water from the Owens Valley, from the Colorado River, and finally from Northern California, water producers in Southern California have been dependent upon underground basins for storage as well as for the flow of fresh water. Building surface structures or towers to store water for peak periods is extremely costly. Since groundwater basins can provide some of this peaking capacity at low cost, the value of the Los Angeles groundwater basins for their storage potential (in contrast to their yield of a water flow) has become their most important function in a complex, conjunctive use system. The loss of one of the groundwater basins underlying metropolitan Los Angeles would be a major economic disaster.

The incentives facing producers of water from an underground basin depend, in part, on the type of property rights system in force at a particular point in time. When groundwater resources were first developed in Southern California, legal relationships were governed by a quasi-riparian doctrine: one could not purchase groundwater rights without purchasing land. Once land had been purchased, however, overlying landowners had the rights to put as much water to beneficial use as they could withdraw. As long as the demand for

groundwater did not exceed the average, long-term supply, no problems resulted from open access to all landowners.

As population and industry increased during the 1930s and 1940s, however, demand for water also increased. An annual overdraft (more water being withdrawn than was being replaced) occurred each year. Several of the basins were located immediately adjacent to the Pacific Ocean. Overdraft in these basins meant not only less water in storage but increased the risk of destroying the basin itself through salt-water intrusion. As water levels fell, each producer was tempted to increase production in order to establish a proportionately larger claim to future pumping rights. The remaining water flowed to the lowest water levels in the basin—allowing sea water to flow in. The short-run incentive was to pump as much as possible before disaster hit.

However, other possibilities existed. If all, or even most, of the pumpers would cut back on production, they could jointly benefit from the prevention of salt-water intrusion. A substantial common good could be achieved if most producers halted their accelerated use. Hundreds of water producers pumped from each basin. No mechanism existed for them to come to agreement concerning joint strategies. No governmental authority had boundaries coinciding with any of the groundwater basins. Portions of eleven cities lay over West Basin, the most exposed one in the series. The County of Los Angeles contained many of the basins within it, but was larger than any one of them.

The problem facing water producers in West Basin by the end of World War II can be clearly represented as a Commons Dilemma. Given the large number of participants and the absence of any ways to communicate and develop enforceable joint production strategies, one would predict from the theory of the commons that the basin would be destroyed by salt-water intrusion within a few years.

But this is a success story. Today, West Basin is in better condition than it was forty years ago. Local water producers found a way to reduce their production from the basin and to create several special districts that now enable them to manage the basin in a productive manner. This "success" was not imposed on West Basin by the State

of California or the U.S. government. The initiatives to cope with their water problems came from the producers themselves and from local governmental officials.

How did this success come about? First, the users established a voluntary private association—the West Basin Water Association—to provide a forum for face-to-face discussion about their common problems. The producers used this forum to obtain the best available evidence about the current conditions of the basin and to discuss alternative joint production strategies. The association was supported by voluntary dues paid by producers based on the volume of water produced. A decision was made within the association to use equity court procedures in helping to solve the problems they faced. Through legal discovery and reference procedures, the producers were able to obtain reliable information on past and current supply and demand conditions.

In the shadow of the court, producers were able to negotiate a contingent contract. This contractual device enabled a producer to agree to limit production if, and only if, 80 percent of the other producers also agreed to limit their production. A contingent contract effectively eliminates being played for a sucker while others pursue temptation strategies. The choice for each producer in deciding whether to sign a contingent contract is between: (1) cooperating in a situation where most others are also cooperating or (2) not cooperating in a situation where most others are also not cooperating. The contingent contract operated as an interim court decree for several years before it became the final court decree and was imposed on nonsigners as well as those who had signed the original agreement. In addition, the court decision assigned each producer defined rights to the flow of water for the basin that could be purchased independently of land. Once rights were so defined, a market for groundwater could and did develop. A water master was appointed to continue to monitor production and ensure that producers remained within agreed limits.

While utilizing court procedures, West Basin producers also initiated proceedings to create several special districts. The first one enabled producers to supplement the underground supply with a

surface supply; the second one enabled them to tax themselves on the amount of water they produced, and to use that tax revenue to engage in replenishment efforts along the coast as well as inland. Replenishment efforts involved several more local public districts that agreed to cooperate in a series of contractual arrangements (see E. Ostrom, 1965, for details; and Blomquist and E. Ostrom, 1985, for a recent analysis).

The participants themselves, in the West Basin Commons Dilemma, were the major actors in designing a series of institutional arrangements to meet their particular needs. Cost-sharing arrangements were developed for each step in the resolution process. The use of proportionate cost sharing began with a voluntary association. Dues were assessed based on the amount of groundwater extracted (thereby creating an incentive to understate use), while votes on association matters were based on the same measure (an offsetting incentive to overstate use). In the court case, costs of investigation and litigation were proportioned to the benefit obtained in the judgment—that is, the prescribed rights to water. The cost of monitoring compliance was again proportioned to rights, with a portion being borne by the State of California. The state has an interest in accurate information about groundwater conditions and in providing facilities to help avoid the tragedy of the commons.

Alanya, Turkey. Our second case stands in marked contrast to the highly modernized political economy of the Los Angeles metropolitan area. The inshore fishery of Alanya in Turkey is a relatively small operation. Fikret Berkes (1986), a human ecologist at Brock University in Ontario, Canada, has provided an excellent description of the fishery and its institutional arrangements. Many of the 100 local fishermen operate in two- or three-man boats using various types of nets. Half of the fishermen belong to a local producers' cooperative and half do not. The economic viability of the fishery in Alanya was threatened in the early 1970s by two factors. First, unrestrained use of the fishery created conflict among the users. Second, competition among fishermen for the better fishing spots greatly increased production costs and uncertainty regarding the

harvest potential for any particular team of fishermen.

Early in the 1970s, members of the local cooperative began to discuss and implement a rather ingenious system for allotting fishing sites to the local fishermen.

- Each September, a list of eligible fishermen is prepared, consisting of all licensed fishermen in Alanya, regardless of co-op membership.
- Within the area normally used by Alanya fishermen, all usable fishing locations are named and listed. These spots are spaced so that the net set in one does not block the fish that should be available at the adjacent spot.
- These named fishing locations are in effect from September to May.
- In September, the eligible fishermen draw lots and are assigned to named fishing locations.
- From September to January, each day, each fisherman moves to the new location to the east. After January, the fishermen move west. This gives each fisherman an equal opportunity at the stocks which migrate east to west between September and January, and reverse their migration from January to May through the area. (Berkes, 1986: 73–74)

Each year the list of fishing sites is endorsed by each fisherman and deposited with the mayor and local gendarme. The few infractions that incur are “dealt with by the fishing community at large, in the coffee house. Violators may come under social pressure and, on occasion, threats of violence” (p. 74). If needed, the local gendarme is prepared to help in the enforcement of the agreement. Enforcement has, however, not been a major problem because the system is supported by most of the fishermen themselves. The system helps to allocate the best fishing sites to all fishermen on an equitable basis and has severely reduced conflict as well as production costs.

Toerbel, Switzerland. The third case is that of Toerbel, a village of about six hundred people located in the Vispental of the Upper Valais region of Switzerland. Netting (1972: 133) identifies the most

significant features of the environment as: “(1) the steepness of its slope and the wide range of microclimates demarcated by altitude, (2) the prevailing paucity of precipitation, and (3) the exposure to sunlight.” For centuries, Swiss peasants have planted their privately owned plots with bread grains, garden vegetables and fruit trees, and hay for winter fodder. Cheeses produced by a small group of herdsmen, who tended village cattle pastured on the communally owned alpine meadows during the summer months, have been an important part of the local economy.

Written legal documents dating back to 1224 provide information regarding the types of land tenure and transfers that have occurred in the village and the rules used by the villagers to regulate the five types of communally owned property: the alpine grazing meadows, the forests, the “waste lands” (stony areas without much vegetation), the irrigation systems, and the paths and roads connecting privately and communally owned properties. On February 1, 1483, Toerbel residents signed articles formally establishing an association to achieve a better level of regulation over the use of the alp, the forests, and the waste lands.

The law specifically forbade a foreigner (*Fremde*) who bought or otherwise occupied land in Toerbel from acquiring any right in the communal alp, common lands, or grazing places, or permission to fell timber. Ownership of a piece of land did *not* automatically confer any communal right (*genossenschaftliches Recht*). The inhabitants currently possessing land and water rights reserved the power to decide whether an outsider should be admitted to community membership. (Netting, 1976: 139)

The boundaries of the communally owned lands were well established long ago as indicated in a 1507 inventory document.

Not only was access to well-defined common property strictly limited to citizens, who were specifically extended communal rights, but regulations written in 1517 specified that “no citizen could send more cows to the alp than he could feed during the winter” (p. 139). This regulation, which Netting reports is still enforced, imposed severe fines for any attempt by villagers to appropriate a larger share of grazing rights. The rules regulating the use of irrigation water

involved an intricate rotation system based on sun and shadow movements on the surrounding mountains. Timber for construction and wood for heating were marked by village officials and assigned by lot to groups of households who then were authorized to enter the forests and harvest the marked trees.

Regulations also stated the obligations of those with use rights to provide labor inputs related to the cleaning of springs, the maintenance of an extensive irrigation system, the construction and maintenance of roads and paths, rebuilding avalanche-damaged fences, and redistributing manure on common pasture lands. A codification of these regulations signed in 1531 included twenty-four separate articles regulating such diverse activities as "immigration to or emigration from the community, hunting on the alp, stock damage to private plots, the spread of cattle disease, dispute settlement, participation in village government, alp pasturate rights, and compulsory communal building" (pp. 139–140).

In addition to a detailed system of communal rights, private rights to land are also well developed in Toerbel and other Swiss villages. Most of the meadows, gardens, grainfields, and vineyards in Toerbel were owned by separate individuals, but complex condominium-like agreements were also worked out for the fractional shares that siblings and relatives might have in barns, granaries, or multistoried housing units.

Hirano, Nagaike, and Yamanoka Villages in Japan. The last case study involves several villages located in a mountainous region of Japan. For centuries in that country, extensive common lands have existed and been regulated primarily by local villagers. In an important study of traditional common lands in Japan, Margaret A. McKean (1986) estimates that about twelve million hectares of forests and uncultivated mountain meadows were held and managed in common by thousands of rural villages during the Tokugawa period (1600–1867), and that about three million hectares are so managed today.

Three Japanese villages—Hirano, Nagaike, and Yamanoka—are similar in many respects to Toerbel. The villages are also established

on steep mountains where many microclimates can be distinguished. Peasants cultivate their own private lands raising rice, garden vegetables, and draft animals. The common lands in Japan produce a wide variety of forest products of value to local peasants including timber, thatch for roofing and weaving, animal fodder of various kinds, and plant and forest residue for fertilizer, firewood, and charcoal.

Each village in earlier times was governed by an assembly. The assembly was usually composed of the heads of each of the households that had political standing in the village. The basis for political status varied substantially by village. In some villages the standing of households was based on cultivation rights in land, in some on taxpaying obligations, and in some on ownership rights in land. In some villages almost all households had political standing and rights to the use of the commons. In others, these rights were more narrowly held (McKean, 1986: 551).

Each village assembly established a relatively complex set of rules regulating both use and enhancement of the commons owned by the village. Boundary rules clearly demarcated which lands were held in common and which in private ownership. Entry rules unambiguously specified who was authorized to use the communally owned land. Ownership of the uncultivated lands near a village devolved from the imperial court to the villages through several intermediate stages involving land stewards and locally based warriors. National cadastral surveys were conducted late in the sixteenth century at a time of land reform that assigned "most of the rights to arable land that we today consider to be 'ownership' to peasants who lived on and cultivated that land" (p. 537). In the earlier systems the owners of large estates had employed agents in each village and authorized these agents to regulate access to the uncultivated lands. As villages asserted their own rights to these lands, they shared a clear image of which lands were private and which were held in common, and of how the lands held in common needed management in order to serve the long-term interests of the peasants dependent upon them. In traditional Japanese villages, the household was the smallest unit of account. Each village contained a carefully recorded, defined number of households. Households could not divide into multiple

households without permission from the village. Rights of access to the communally held lands were accorded on a pro rata basis to each household. Consequently, households with many members had no advantage, and considerable disadvantages, in their access to the commons. Population growth was extremely low (0.025 percent for the period 1721–1846) and ownership patterns within villages were stable (p. 552).

In addition to delimiting the ownership status of all lands, village assemblies also established detailed partitioning rules (Oakerson, 1986), which specified in various ways how much of each valued product a household could harvest from the commons.

Different villages arrived at different arrangements for guaranteeing an adequate supply of the products from the commons. For items that were needed regularly and that the commons yielded in abundance, a village might allow co-owners free and open entry as long as they abided by certain rules to make sure that a self-sustaining population of mature plants or animals was left behind. To enter the commons, one might need to go to village authorities to obtain an entry permit, carved on a little wooden ticket and marked 'entrance permit for one person.' The rules would probably restrict the villager's choice of cutting tools or the size of the sack or container used to collect plants. Everyone would be expected to abide by the village headman's instructions about leaving so much height on a cut plant so that it could regenerate, or taking only a certain portion of a cluster of similar plants to make sure the parent plant could propagate itself, or collecting a certain species only after flowering and fruiting, and so on.

Villagers usually set aside closed reserves . . . for items that had to be left undisturbed until maturity and harvested all at once at just the right time, or that the commons supplied in only adequate, not abundant, amounts. The village headman would be responsible for determining when the time had come to harvest thatch or winter fodder or other products, and would schedule the event. (McKean, 1986: 555)

The tailoring of village rules to the specific needs of each village and the ecological condition of a particular commons also required input from the villages to enhance and maintain the yield of the commons.

There were written rules about the obligation of each household to contribute a share to the collective work to maintain the commons—to conduct the annual burning . . . , to report to harvest on mountain-opening days, or to do a specific cutting of timber or thatch. Accounts were kept about who contributed what to make sure that no household evaded its responsibilities unnoticed [and] if there was no acceptable excuse, punishment was in order. (McKean, 1986: 559)

McKean's study is also strong testimony that it is possible for local communities to devise effective rules for managing their own common-property resources. The establishment of the rules, the monitoring of behavior, the monitoring of the conditions in the commons, and the assignment of punishment were all conducted primarily in the village. McKean concludes that the long-term success of these locally designed rules systems indicates "that it is not necessary for regulation of the commons to be imposed coercively or from the outside" (p. 571).

What Can Be Learned from These Cases?

Let me turn first to the substantive lessons that can be learned from these four success stories. I will follow this with a discussion of the methodological lessons.

The Substantive Significance. The most important substantive lesson to be learned from these four cases is that it is *possible* for individuals facing a Commons Dilemma in natural settings to design their own institutional arrangements that change the very structure of the situation in which they find themselves. A self-conscious process of institutional change occurred in West Basin and in Alanya. The participants designed new structures for themselves that have enabled them to use common-pool resources in a productive manner. In West Basin, a rich supporting institutional structure enabled participants to enter into contingent contracts, to agree to create special districts with specific powers to tax, and to engage in a creative form of public entrepreneurship to manage the commons. In Alanya, relatively poor fishermen, living in marginal circumstances, were able

to extricate themselves from a deteriorating Commons Situation by inventing an ingenious set of rules for rotating fishing sites, enabling everyone to have a fair opportunity to obtain the catch.

These are not unique cases. In Southern California, participants in other groundwater basins have developed similar institutional arrangements to those of West Basin (Weschler, 1968; Rolph, 1982; Blomquist, 1987). While the designs are similar, each is tailored to meet particular circumstances. Besides Alanya, Berkes describes two other inshore fisheries owned communally where local fishermen have developed effective institutions for regulating use. The rules used in these other fisheries are different from those used in Alanya. Swiss peasants living in other alpine villages besides Toerbel have evolved their own systems for allocating the use of common grazing land (Wiegandt, 1977). Many other success stories are recorded in the literature (Siy, 1982; Wade, 1986; Cruz, 1986; Berkes, 1985a, 1985b; Uphoff, 1985; McCay, 1980; Berkes and Pockock, 1981; Acheson, 1975; Cordell and McKean, 1986).

Success is, of course, not the only outcome. In Northern California, Arizona, and New Mexico, many groundwater basins are currently threatened with excessive depletion (Knapp and Vaux, 1982). Several inshore fisheries on the Turkish coast, not far from Alanya, face resource depletion and severe user-group conflicts (Berkes, 1986). Establishing a *possibility* is not the same as establishing *necessity*.

West Basin and Alanya illustrate how individuals can engage in self-conscious design to change patterns of behavior within a relatively short period of time. These cases illustrate what I think Giddens (1979: 56–57) means by the reflexive monitoring of action. Giddens considered this reflexive monitoring to be related not only to the actions taken in a situation but also to the “monitoring of the *setting of interaction*” (his emphasis). The Swiss and Japanese villages illustrate how institutions that evolved in the distant past can be well adapted to particular environmental and cultural circumstances. That the inhabitants of these extremely fragile mountain environments have been able to use them intensively for centuries, while harvesting a rich variety of forest and forage products, is strong

testimony to the possibility of long-term, stable outcomes that are not the tragedies posited in theory.

Another lesson to be obtained from these cases is the futility of presuming that there is “one best way.” There cannot be “one best way” for relating to an infinite variety of different problematical situations. None of the four institutional arrangements that enabled participants to overcome a Commons Dilemma is either a strict market or a central-government arrangement. While the West Basin “solution” involves firm property rights to the flow of water, the basin itself is not privately owned. A “market” for water rights emerged subsequent to the court decree allocating rights to water. But that is not all that emerged. Water producers created several local, public jurisdictions with regulatory and taxing authority to supplement their own efforts to use equity court procedures to assign firm rights to the flow of water and thus control the total withdrawals from the basin. A complex series of private and public agencies jointly manage this sensitively balanced system. Nor is the polycentric, locally governed system, involving both private and public enterprises, a central-government solution.

In none of the other systems do the rights to use even approach fully marketable rights. In Alanya, one must be a registered fisherman living in Alanya to qualify for the annual lottery. One fisherman cannot sell his annual schedule of fishing spots to another. Rights to the Toerbel commons are individually inherited, but an outsider cannot buy rights to use the commons as an outsider can buy water rights in West Basin. Rights to use of the Japanese village commons are assigned to family units and remain with family units from one generation to the next.

None of the four systems resembles a central-government solution, either. The participants themselves decided which rules are to apply for allocating use. The administrative structure in all four cases is minimal. The users of the commons are also the governors of the commons.

The primary substantive lesson from these cases is that it is possible for humans to break out of the logic that yields a tragedy of the commons and to restructure the situation itself. Thus it is

important for policy analysts to recognize the difference between making assumptions during an analysis and presuming these assumptions are immutable. There cannot be “one best way” of organizing the management of natural resource systems. We have much more to learn from careful analysis of existing institutional arrangements.

The Methodological Significance. These cases not only teach us substantive lessons; they also raise methodological issues about how to study institutions and institutional change. In my earlier discussion, I referred to most current analyses of Commons Dilemmas as single-level analyses. The analysis is completely contained within the structure of a given situation. The problem in understanding institutions is that one must use multiple levels of analysis. Several ways exist to identify levels. One method is to separate levels of operational choice, collective choice, and constitutional choice (see Kiser and E. Ostrom, 1982). The typical way of modeling a Commons Dilemma is at the level of operational choice. Analyzing how individuals might change the rules of a situation involving operational choice is at a level of collective choice. Analysis of the rules for making rules is at a level of constitutional choice (Buchanan and Tullock, 1962). When we move from an analysis at one level to a prescription for changing the rules used by people to structure that level, we need self-consciously to use multiple levels of analysis (see V. Ostrom, 1985: ch. 13).

This is a central theme in Douglas Hofstadter's *Godel, Escher, Bach* (1979). Hofstadter distinguishes between systems in which the levels are well separated in time, in space, and in the language used to describe them, and systems in which they are not well separated.

In multilevel systems that are well separated in time and space, no more than one level of analysis must be kept in mind at any one time. Our minds can effectively jump from one level to another depending upon the context of discourse and thought. In many physical systems, for example, various levels of analysis are effectively separated by large gaps in space and/or time.⁸ The vast differences in time and space between many levels of physical systems have enabled physical scientists to develop a technical language and theoretical

apparatus to explain phenomena at each level relatively independently of other levels.

There are, however, physical systems where the macroscopic behavior of the system emerges from the “independent behaviors of a multitude of microscopic entities” (Courtois, 1985: 592). Ilya Prigogine (1978) has called some of these systems “dissipative structures.” They occur in both the physical and biological worlds. Problems of analysis for physical and biological phenomena that are more tightly linked across levels turn out to be far more difficult than analysis where levels can be kept separate. Social and political phenomena are similar in structure to such tightly linked systems and present similar difficulties of analysis.

Hofstadter discusses such difficulties when he argues that what is most confusing “is when a single system admits of two or more descriptions on different levels which nevertheless resemble each other in some way” (1979: 287). He warns that when levels tend to resemble one another closely, “we find it hard to avoid mixing levels when we think about the system, and can easily get totally lost” (p. 287). Hofstadter illustrates the confusion that can result when similar language is used to describe multilevel systems with the problems faced in designing, managing, and fixing errors in computer systems, with their complex layering of programming languages. Those of us who have taught a friend to use a microcomputer are all too familiar with the initial confusion of a novice when faced with the multiple language systems he or she must learn to use. Since all communication with the computer occurs on the same flat screen, the novice interprets the symbols as all coming from the same level. Sorting out what an operating language does from what other, higher-level, languages do is a major task for anyone who works with a computer.

In a similar manner, many social scientists would view the various actions undertaken by participants in West Basin or in Alanya as occurring at one level—what we might refer to as “local level” phenomena. Social scientists tend to distinguish phenomena in terms of space, whether local, regional, national, or international, and time—the Dark Ages, the Middle Ages, the Enlightenment, and

the Modern Era, for instance.⁹ Another device for grouping similar and dissimilar events is the distinction between government and nongovernment. With this distinction, activities undertaken in West Basin would be classified as part of local government, while the activities undertaken in Alanya would be classified as occurring in the private sector. In the approach presented here, however, the water producers in West Basin and the fishermen in Alanya are both conceptualized as involved in a *similar* but *multilevel* series of activities. They solve a similar problem (the Commons Dilemma) at an operational level by restructuring, at a different level (the collective choice level), the rules affecting their use of the commons.¹⁰ They function at a constitutional level in doing so.

Game theory has developed a rich and useful set of tools to enable scholars to predict outcomes once the structure of a situation is represented as a game. We need to develop a complementary "rules theory" with its own set of tools to enable us to predict the structure of the game that will be produced by particular configurations of rules when used in combination with the physical laws of the environment (see Elkin, 1985, for a similar argument). A theory of rules, combined with game theory, would then provide the basis for rule modifications that may improve rather than diminish human welfare. We have a rich literature in political philosophy to draw upon in developing a theory of rules.¹¹ Further, considerable work in formal logic, particularly deontic logic, and in artificial intelligence, communications theory, sociolinguistics, developmental cognitive psychology, and linguistics itself is relevant to the study of rules.

One of the problems facing scholars who have been interested in the rules used by people to order their relationships with one another has been the extraordinary variety of particular rules. Until a technical language is developed to express in a more generic form the particular rules found in practice, one rule configuration cannot be compared to another. Rules in use are described either in everyday language or in the legal language of a particular legal system. The variety of rules, if one relies entirely on the specific wording of rules found in practice, is beyond our capacity to analyze.

In our current research, my colleagues and I at the Workshop in Political Theory and Policy Analysis are developing a method to represent rules in a generic fashion. We are attempting to identify what is common to a set of specific rules and to capture that commonality in as simple a statement of rules as we can. A complete generic rule configuration affecting the structure of a game would contain rules clarifying the following:

- What positions participants may, must, or must not hold (*position* rules);
- What characteristics participants may, must, or must not have to enter positions (*boundary* rules);
- The authorized actions participants may, must, or must not take independently (*authority* rules);
- The formula that participants may, must, or must not use for decision making, when multiple persons must decide (*aggregation* rules);
- The information that participants may, must, or must not reveal to others (*information* rules);
- The states of the world that participants may, must, or must not affect (*scope* rules);
- The rewards or penalties that may, must, or must not be assigned to actions or outcomes (*payoff* rules).¹²

This is not the appropriate place for a detailed examination of the methods we are developing. Let me illustrate them, however, by concentrating on eight generic rules that were changed in West Basin, four of which were also changed in Alanya. While in both cases other rules are also involved, these eight rules were the focus of attention in West Basin. A generic formulation of each rule is presented in Table 4.1.

Four rules were changed in the Alanya case: (1) local civil authorities became official monitors for the fishing agreement, (2) fishermen were limited in the number of days they were allowed to

Table 4.1
Rules That Were Changed in the Alanya or West Basin Cases

| RULES CHANGED | "BEFORE" | | "AFTER" | |
|--|----------|------------|---------|------------|
| | Alanya | West Basin | Alanya | West Basin |
| Position rules | | | | |
| P1. Position of monitor exists | N | N | Y | Y |
| Entry rules | | | | |
| E1. Must live (or own land) in local area to be a user | Y | Y | Y | N |
| E2. May purchase entry rights | N | N | N | Y |
| Authority rules | | | | |
| A1. Quantity of use restricted | N | N | Y | Y |
| A2. Location of use restricted | N | N | Y | Y |
| Payoff rules | | | | |
| R1. Sanctions could be imposed on use patterns | N | N | Y | Y |
| R2. Payments assessed on quantity of use | N | N | N | Y |
| R3. Payments assessed on assets | N | N | N | Y |

fish, (3) fishermen were limited in the location where they could fish, and (4) sanctions could be imposed on those who did not adhere to the restrictions placed on use patterns. In West Basin, all eight of the rules listed in Table 4.1 were changed over a twenty-year period.

By stating the rules in a general rather than a specific form, we can now observe that these eight rules were similar in both Alanya and West Basin "before" they were changed because participants in both locations faced a Commons Dilemma. The similarity in the underlying

rule structure is otherwise hidden in the complexity of a modified quasi-riparian water rights doctrine and an open-access fishery regime. In our current research, we are beginning to examine the rule configurations underlying a series of cases similar to those described above in order to ascertain how similar generic rules are related to Commons Dilemmas. From our early results, we know that the generic rule configurations underlying such dilemmas are subject to greater variance than those that apply to Alanya and West Basin. But it will still be possible to associate some types of rule configurations with some types of situations in a systematic manner.

While the "before" rules are identical in their generic structure, the "after" rules are not. Entry rights may be purchased in West Basin and not in Alanya. It is necessary to live in the local area in Alanya and not in West Basin. Further, payments for use as well as payments on assets are assessed in West Basin and not in Alanya. The system to regulate use patterns in Alanya is a far simpler system than the one developed to regulate use in West Basin. Furthermore, in West Basin, users have organized themselves for the purpose of enhancing and regulating the supply of water to the basin as well as regulating the use patterns made of the basin.

The Alanya rule configuration is quite similar to the ones that evolved in Toerbel and in Harano (to take one of the Japanese villages as an example). The generic rules we compared can also be applied to the success cases: the traditional systems that evolved in

| | Generic rule number | | | | | | | |
|----------------------------------|---------------------|----|----|----|----|----|----|----|
| | P1 | E1 | E2 | A1 | A2 | R1 | R2 | R3 |
| Toerbel, Switzerland | Y | Y | N | Y | Y | Y | N | N |
| Harano, Japan | Y | Y | N | Y | Y | Y | N | N |
| Alanya, Turkey ("after") | Y | Y | N | Y | Y | Y | N | N |
| West Basin, California ("after") | Y | N | Y | Y | Y | Y | Y | Y |

Toerbhel and in Harano and the "after" situations of Alanya and West Basin.

The similarity in the pattern for these eight rules for Toerbhel and Harano is striking. This portion of the rule configuration is identical for two systems that evolved in widely separated, fragile mountain regions in Switzerland and Japan.¹³ Without transforming the particularities of the actual rules used in each of these settings into a general form, this underlying similarity in structure is difficult to observe. Although our work on generic rule formulation is just beginning, we can begin to see what it means to sort out multiple levels of analysis and develop technical languages appropriate to each of the levels. Analysis of rule configurations requires an examination of how particular patterns in rules-in-use affect the structure of the situations humans confront. Analysis of these situations, in turn, requires an examination of how incentives so produced lead to particular types of behavior and aggregate outcomes. To develop a cumulative and effective form of policy analysis, we need to pursue *both* types of analysis as rigorously as we can. Without the analysis of rules, the analysis of given situations leads to a focus on the immutable structure of the situation. Without the analysis of situations, the analysis of rules does not tell us how people will behave once rules have been changed (see Majone, 1986: 70).

By learning to understand how rules can be used to restructure such nasty social traps as Commons Dilemmas, we may come to appreciate that alternatives are available for resolving other social dilemmas. Human beings not only face choices about how to act in given situations; they also have the capacity to think about, formulate, and select different ways of structuring choice situations. Choices occur in different contexts and at different levels. When people learn not only how to use a commons but how to govern a commons, they are laying the foundation for developing and maintaining self-governing, democratic societies.

Notes

1. Recent historical work has challenged the validity of the presumption that there was a tragedy of the commons in the use of English open-field grazing lands, but the metaphor of the commons is still quite useful in other settings (Dahlman, 1980).

2. Attributed to Merrill M. Flood and Melvin Dresher and formalized by Albert W. Tucker (Campbell, 1985: 3), the game is described as follows.

Two suspects are taken into custody and separated. The district attorney is certain that they are guilty of a specific crime, but he does not have adequate evidence to convict them at a trial. He points out to each prisoner that each has two alternatives: to confess to the crime the police are sure they have done, or not to confess. If they both do not confess, then the district attorney states he will book them on some very minor trumped-up charge such as petty larceny and illegal possession of a weapon, and they will both receive minor punishment; if they both confess they will be prosecuted, but he will recommend less than the most severe sentence; but if one confesses and the other does not, then the confessor will receive lenient treatment for turning state's evidence whereas the latter will get "the book" slapped at him. In terms of years in a penitentiary, the strategic problem might reduce to:

| | | <u>Prisoner 2</u> | |
|-------------------|--------------------|-----------------------------------|-----------------------------------|
| | | <u>Not Confess</u> | <u>Confess</u> |
| <u>Prisoner 1</u> | <u>Not confess</u> | 1 year each | 10 years for 1, 3 months for 2 |
| | <u>Confess</u> | 3 months for 1, 10 years for 2 | 8 years each |

(Luce and Raiffa, 1957: 95).

Richard Kimber (1981) challenges the appropriateness of using the PD game to represent Commons Dilemmas.

3. Scholars engaged in experimental work have examined a variety of factors that may affect the proportion of cooperative vs. noncooperative strategies (see, in particular, R. Wilson, 1985; van de Kragt, Orbell, and Dawes, 1983; Dawes, McTavish, and Shaklee, 1977).

4. In an important article that presumes that there may be different institutional solutions to such situations, Orbell and Wilson (1978) examine the effect of using a single dictator, majority rule, or unrestrained choice to determine who cooperates and who defects under different environmental conditions.

5. Anthony Giddens (1979: 5) has stressed this basic recursiveness of social life by pointing out that "structure is both medium and outcome of the reproduction of practices."

6. In a fascinating study of the unintended and perverse consequences of national governmental regulation of coastal fishery resources, Anthony Davis (1984) points out that officials of the Canadian Federal Department of Fisheries are firmly convinced that a "tragedy of the commons" will occur in all fisheries without a uniform imposition of central regulations. These national regulations ignore and, in some cases, are contrary to local regulations for managing small-boat fisheries that have been in practice for several generations. The national policies are generating substantial threats to the long-term viability of small-boat fisheries that had been ecologically viable for a long time.

7. Substantial work has been undertaken in modern game-theory literature on much more complex situations than the standard PD or Commons game in modern game theoretical literature (see, for example, Selten, 1975, 1978; Shubik, 1982; Guth, 1985).

8. In a kinetic model of a chemical reaction, the differential equations used to represent the chemical reaction rely on an assumption that the process under analysis can be isolated from its environment. P. J. Courtois has described these multilevel, chemical systems in the following way.

On the one hand, the environment is supposed to remain unaffected and is held constant; it is represented by a few parameters with fixed

values. On the other hand, underlying processes, at finer scales in time or space, are hidden. Their dynamics are completely ignored. They are supposed to be in a state of equilibrium. . . . The success and the accuracy of these isolated analyses are, of course, to a great extent due to the large values of the differences in the time and size scales of the structures involved. (Courtois, 1985: 591)

9. A glance at the curriculum for many social science departments reveals some variant of the above spatial or temporal divisions. While these temporal and spatial classifications are useful for many purposes, they are not the only useful ways of examining the layers of interlinked systems of human action.

10. Biology and linguistics both advanced rapidly once the multileveled nature of these disciplines was recognized and a different language developed for each level. Both genotypes and phenotypes are basic structures used in the analysis of living systems. Analysis of a genotype explores the genetic constitution of an organism; analysis of a phenotype looks at the physical manifestations of the individual members of a species. The methods of analysis and scientific language used to describe and explain phenomena at each of these levels differ markedly even though, to understand evolution, one needs to understand both types of structure and how they are related. Modern linguistics has also been well served by a conscious separation of the level of sentence structure from the deeper transformational grammatical structure. This has represented a slow development over time of the work of Humboldt (1836), de Saussure ([1916] 1960), Wittgenstein (1953), and Searle (1969). One of Chomsky's great contributions has been to show that the technical language appropriate for describing and theorizing about a deep transformational grammar is not the same language or level that is used to analyze surface structure (see Chomsky, 1965, 1975, 1978). The analysis of institutional arrangements in the social world needs a similar methodological severing of conceptually close systems and the development of different technical languages for each level of analysis. This does not mean that the levels are severed in everyday life, but that they are perceived as separable by social scientists for analytic purposes. The linkages among levels are so intimately intertwined that it is extraordinarily difficult to separate them for analysis.

11. See Buchanan and Tullock (1962), Hayami and Ruttan (1985), North (1981), V. Ostrom (1980, 1982, 1987), and Shepsle (1979a, 1979b).

12. See E. Ostrom (1986a, 1986b, 1987) and Kiser and E. Ostrom (1982) for discussion of the relationship of particular types of rules to the elements of an action situation. See Feeny (1986) for a discussion of related methodological issues that arise in studying Commons Dilemmas.

13. Most of the other rules used in these two cases are also quite similar. They differ primarily in regard to how rights are transferred across generations and the freedom individuals have to leave their villages (see E. Ostrom, 1987, for a more thorough description).

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