

HOW INEXORABLE IS THE "TRAGEDY OF THE COMMONS?"
INSTITUTIONAL ARRANGEMENTS FOR CHANGING THE STRUCTURE
OF SOCIAL DILEMMAS

by

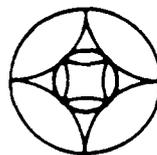
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Workshop in Political Theory and Policy Analysis
Indiana University
Bloomington, Indiana

Distinguished Faculty Research Lecture, Indiana University, April 3,
1986.

I am appreciative of the support made available through the National
Science Foundation Grant Number NSF SES 83-09829, and the helpful
comments of Christi Barbour, Fikret Berkes, William Blomquist, David
Feeny, Vincent Ostrom, Rick Wilson, and James Wunsch.

*WORKSHOP IN
POLITICAL THEORY &
POLICY ANALYSIS*



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Since Garrett Hardin's captivating article in Science (1968), the expression, "the tragedy of the commons," has come to symbolize the degradation of the environment to be expected whenever many individuals own a scarce resource in common. Godwin and 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 direct return from selling 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 proceeds from the sale of his own animals and bears only a share of the costs resulting from over-grazing. 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: 1,244).

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, Book II, Ch. 3). Over 150 years ago, William Forster Lloyd (1833; reprinted 1977) sketched a theory of the commons, which predicted improvident use for property owned in common. More than a decade before Hardin's article, H. Scott Gordon, of our own faculty, clearly expounded "The Economic Theory of a Common-Property Resource: The Fishery" (1954), in what has become a classic of 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, the theory that Hardin sketched has been formalized as a N-Person, Commons Dilemma Game (Dawes, 1973; 1975). When the

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.

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 so-called 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

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:

(Footnote continued)

Don't Cooperate	Best Result for 1 Worst result for 2	Third best result for both
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The Prisoner's Dilemma game has fascinated scholars in many fields. 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 a recently published book, 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 on it. At latest count -- a decade ago -- more

²(continued)

		Prisoner 2	
		Not Confess	Confess
Prisoner 1			
Not Confess		1 year each	10 years for 1 3 months for 2
Confess		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.

than 2,000 papers had been devoted to the Prisoner's Dilemma game (Grofman and Pool, 1975).

When viewed as a situation that will be repeated for a finite and known number of rounds, most theorists predict that players will continue to select their dominant strategy in each round yielding a deficient equilibrium over the series of plays. Several predictions are made for an iterated Commons Dilemma game when the number of iterations is unknown. Many philosophers and formal 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 indefinite future 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). 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 which predict the selection of cooperative strategies by all (see Lewis and Cowens, 1983; Cave, 1984; Bendor and Mookherjee, 1985). Taking an evolutionary approach, Axelrod (1981; 1984) has examined which strategies may be collectively stable under varying conditions of long-term play.

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 The "solution" is viewed as

³ Scholars engaged in experimental work have examined a variety of
(Footnote continued)

immutable. From within the game, participants are trapped in an eternal struggle of tragic proportions. Even when analysts have examined situations which 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 on which the PD game is based were indeed trapped. The physical constraints of separate cells in a prison and a resolute District Attorney impose an immutable structure upon them. Is this immutability a temporary conceptual and methodological constraint or a deeper substantive necessity? Scholars and government officials presume that all participants in situations with the structure of a PD game are necessarily trapped in the structure of the situation; as prisoners are trapped in their cells, participants are themselves trapped in their own mental apparatus. 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 an empirical reality in some situations. It is not an empirical reality in many situations, however.

³(continued)

factors which 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.

All analysis is based on assumptions which 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 on-going, complex, multi-level world of action, what is exogenous at one level of analysis may be endogenous at another level of analysis.⁵ This fixation on the rigidity of analytical constraints has had unfortunate consequences when scholars have turned from analysis to prescription. The grim predictions generated by many analysts about the Commons Dilemma has led to policy recommendations of an equally grim character. 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" (1973: 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

⁵ Anthony Giddons (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."

alternatives to the Commons Dilemma are what he calls "a private enterprise system" on the one hand or "socialism" on the other (1978: 314). With the assurance of someone convinced that "the alternative of the commons is too horrifying to contemplate" (1968: 1,247), 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" (1978: 314).

The presumption that Leviathan is necessary to avoid tragedies of the commons leads some analysts to recommend central government control of most natural resource systems. Robert L. Heilbroner (1974) opined that "iron governments," perhaps military governments, are necessary to achieve control over ecological problems. In a somewhat less Draconian view, 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

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
(Footnote continued)

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."

What is perplexing, as well as dangerous, is that scholars are willing to propose the imposition of sweeping institutional changes without a rigorous analysis of how different combinations of institutional arrangements work in practice. The current lack of sophisticated analyses of alternative institutional arrangements is a

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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 which had been ecologically viable for a long time.

major weakness of contemporary work in the social sciences. Limiting institutional prescriptions to either "the market" or "the state" means that the social-scientific "medicine cabinet" contains only two nostrums.

Game theory has provided powerful tools for analyzing certain situations. The tools exist to analyze far more complicated situations than the simple game that is repeatedly used to "illustrate" the Commons Situation. Social scientists and philosophers 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? What is a 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, cajole, or retaliate.

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

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

situation from cooperating with one another. Some cooperation among participants may lead to harms externalized on others, such as in criminal conspiracies or economic cartels. Thus, 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 and want now to 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 which have not resulted in tragedy. If we are to understand how individuals can escape from tragedy, we need to study such "success" stories carefully. These are particularly interesting success stories because none of them relies on central control nor market mechanisms as its primary mode of management. Empirical cases provide the grist for further theoretical development. Once I have presented these four cases, I will then turn to several substantive and methodological lessons to be learned from the analysis of these success stories.

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 the area

during the twentieth century. Metropolitan Los Angeles has the fortuitous circumstance that it overlies 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 peaking purposes is prohibitively costly. Since groundwater basins can provide some of this peaking capacity at low cost, the value of the groundwater basins for their storage potential (as contrasted to their flow of water) 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 riparian-like 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 the 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 continued overdraft could destroy the groundwater basin itself through salt water intrusion. Each producer faced a perplexing problem. As water levels fell, each producer was tempted to increase production in order to establish a proportionately larger claim to future pumping rights. Water that was not used simply flowed to the lowest water levels in the basin -- allowing sea water to flow into the basin. 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 11 cities lay over West Basin, the most exposed basin in the series. The County of Los Angeles contained many of the basins within it, but was larger than any one of them.

By the end of the second World War, the problem facing water producers in West Basin 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 West 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 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 nonsignators 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 which 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 special district enabled producers to supplement the underground supply with a surface supply. The second district enabled producers 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 which 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 the 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 also based on groundwater extraction (an offsetting incentive to overstate use). In the court case, costs of investigation and litigation were proportioned to the benefit obtained in the judgment -- i.e., the prescribed rights to water. The cost of monitoring compliance is 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 the provision of 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 (1985c), 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 2- or 3-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. Secondly, competition among fishermen for the better fishing spots greatly increased production costs and uncertainty regarding the harvest potential for any particular team of fishermen.

Fifteen years ago, members of the local cooperative began to discuss and implement a rather ingenious system for allotting fishing sites to the local fishermen. Fikret Berkes has described the system in the following words:

- a. Each September, a list of eligible fishermen is prepared, consisting of all licensed fishermen in Alanya, regardless of co-op membership.
- b. 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.
- c. These named fishing locations are in effect from September to May. . . .
- d. In September, the eligible fishermen draw lots and are assigned to named fishing locations.
- e. 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, 1985c: 14-15).

Each year the list of fishing sites is endorsed by each fisherman and deposited with the mayor and local gendarme. The few infractions which 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" (Berkes, 1985c: 15). 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.

Törbel, Switzerland

The third case is of Törbel, a village of about 600 people

located in the Vispertal of the Upper Valais region of Switzerland. Netting (1976: 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, the irrigation systems, and the paths and roads connecting privately and communally owned properties. On February 1, 1483, Törbel 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 Törbel 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 written regulations specified in 1517 that "no citizen could send more cows to the alp than he could feed during the winter. . . ." (Netting, 1976: 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 24 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" (Netting, 1976: 139-140).

In addition to a detailed system of communal rights, private rights to land are also well developed in Törbel and other Swiss villages. Most of the meadows, gardens, grainfields, and vineyards in Törbel were owned by separate individuals, but complex condominium-like agreements were also worked out for the fractional

shares that siblings and relatives may have in barns, granaries, or multi-storied 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 (1984) estimates that about 12 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 3 million hectares are so managed today. While many villages have sold or divided their common lands in recent times, McKean (1984: 2) indicates that she has "not yet turned up an example of a commons that suffered ecological destruction while it was still a commons."

Three Japanese villages -- Hirano, Nagaike, and Yamanoka -- are similar in many respects to Törbel. The villages are also established on steep mountains where many micro-climates can be distinguished. Peasants cultivated 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

which 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, some on taxpaying obligations, and 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, 1984: 26).

Each village assembly established a relatively complex set of rules regulating both the use and enhancement of the commons owned by the village. Boundary rules clearly demarked 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" (McKean, 1984: 6). 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 those 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 (.025 percent for the period between 1721-1846) and ownership patterns within villages were stable (McKean, 1984: 29).

In addition to delimiting the ownership status of all lands, village assemblies also established detailed partitioning rules (Oakerson, 1984) specifying 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 each of these products. 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 villagers' 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.

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 only in adequate, not abundant, amount, villagers usually set aside closed reserves. . . . 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, 1984: 33).

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.

For 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 -- there were written rules about the obligation of each household to contribute a share to this effort. 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, 1984: 39).

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 from the outside" (McKean, 1984: 56).

What Can We Learn From These Cases?

Let me turn 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 new political jurisdictions 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). 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 Törbel 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, 1985; Cruz, 1985; Berkes, 1985a; 1985b; Uphoff, 1985; McCay, 1980; Berkes and Pockock, 1981; Acheson, 1975).

Success is, of course, not the only outcome. In Northern California, Arizona, and New Mexico, many groundwater basins are currently being threatened with excessive depletion (Knapp and Vaux, 1982). On the Turkish coast several inshore fisheries, not far from Alanya, face resource depletion and severe user-group conflicts (Berkes, 1985c). 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 Giddons (1979: 56-57) means by the reflexive monitoring of action. Giddons 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 which 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 learned from these four cases is that it is essential for those interested in proposing ways of improving human welfare to recognize the difference between the methodological requirement of exogenous variables and the mutability or immutability of these same variables. To analyze an action situation, the theorist must assume some variables are beyond the control of individuals in

the situation. This methodological device of placing some variables outside short-term control enables the analyst to understand the logic of the short-term situation and to predict likely patterns of behavior in short-term situations of a similar structure. Something must be taken as given in any analysis. The variables which are considered exogenous may or may not be under the long-term control of participants. In some political systems, users of common-pool resources cannot affect the institutional structure of their common resource and are like prisoners trapped in their cells. But our cases illustrate that, when users of a common-pool resource do have long-term capacities to change their own institutional arrangements, it is possible for them to create new arrangements well tailored to their particular circumstances. Consequently, no logical or empirical necessity traps users of a common-pool resource into an inevitable tragedy.

Instead of the users of a commons being inextricably trapped in a tragedy, it is scholars who have allowed their assumptions to trap them into a presumption that short-run tendencies will necessarily prevail in the long run.⁸ As long as scholars are enmeshed in a

⁸ Examples of scholars who stress the inescapable nature of the problem include Smith (1981: 465), who asserts that "it is by treating a resource as a common property that we become locked in its inexorable destruction." Stillman pointed out a decade ago that the "remorseless logic" was built into the assumptions of Hardin's theory. In his words:

But the search for a solution cannot be found within the parameters of the problem. Rather, the resolution can only be found by changing one or more of the parameters of the problem, by cutting the Gordian knot rather than untying it (Stillman, 1975: 14).

conceptual trap, they fail to address how participants in a Commons Dilemma can restructure their relationships to achieve mutually productive ways of relating to one another. Further, presuming the helplessness of participants leads to recommendations to impose solutions upon them. If we had strong logical and empirical reasons to believe that there is only "one best way" to avoid Commons Dilemmas, then we might urge the imposition of a single institutional arrangement for efficiency's sake.

But another lesson obtained from these cases is the futility of presuming there is "one best way." None of the four institutional arrangements which successfully overcame a Commons Dilemma is either a strict market arrangement or a central-government arrangement. While the West Basin "solution" does involve creating firm property rights to the flow of water in West Basin, 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 went on to create several local, public jurisdictions with regulatory and taxing authority to supplement their efforts to control the basin through the assignment of fixed rights to water. 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, local fisherman to qualify for the annual lottery. One fisherman cannot sell his annual schedule of fishing spots to another. Rights to the

Törbel Commons are individually inherited, but an outsider cannot buy rights to use the commons like 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 of the commons and to restructure the situation itself. Thus, it is important for policy analysts to recognize the difference between assuming a set of givens during an analysis and presuming these givens are really unchangeable. We have also observed that there may not be "one best way" of organizing for the management of natural resource systems. At least we are now aware of several systems which work quite well without being either pure market or pure central control systems.

The Methodological Significance

These cases do not only teach us substantive lessons; they also raise important methodological issues about how to study institutions and institutional change. In my earlier discussion, I referred to 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 an operational choice level. Analyzing how individuals might change the rules of an operational choice situation is at a collective choice level. And, further, analysis of the rules for making rules is at a constitutional choice level. When we move from an analysis at one level to a prescription for changing the rules used by people to structure that level, we must self-consciously use multiple levels of analysis.

I cannot emphasize too strongly the importance of recognizing the necessity for self-conscious and rigorous analysis of multi-level systems if social scientists are to contribute to the improvement of social welfare. An assertion that there are multiple levels of analysis in the social sciences is not revolutionary. But until we begin to develop rigorous methods for separating the various levels, we will continue to thrash about in our own confusion (see V. Ostrom, 1985a; 1985b). This is a central theme in Richard Hofstadter's Gödel, Escher, and 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, from systems which are not well separated.

In multi-level systems which are well separated in time and space, we do not need to keep more than one level of analysis 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. 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 multi-level, 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).

The vast differences in time and space between many levels of physical systems has 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). Prigogine (1978) called some of these systems "dissipative structures." They occur in both the physical and biological world. Problems of analysis for physical and biological phenomena which 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" (1979: 287). Hofstadter illustrates the confusion which can result when similar language is used to describe multi-level 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 micro-computer 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 -- local, regional, national, or international -- and time -- the Dark Ages, the Middle Ages, and the Enlightenment, for instance.⁹

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
(Footnote continued)

Another way of grouping similar and dissimilar events is the distinction between government and non-government. Using this distinction, activities undertaken in West Basin would be classified as occurring at one level -- local government. With this analytical scheme, the activities undertaken in Alanya would be viewed as something entirely different: something outside the bounds called government. In the approach presented here, the water producers in West Basin and the fishermen in Alanya are conceptualized as both being involved in a similar but multi-level series of activities. They are attempting to solve a similar problem (the Commons Dilemma at an operational level) by restructuring, at a collective choice level, the underlying rules affecting their day-to-day activities. Viewing these two cases as representing similar but multi-level phenomena is not the dominant way of classifying phenomena in the social sciences today.

Where would biology be today if it were still organized primarily around the study of "the flora and fauna of X region?" Fortunately, earlier generations of biologists recognized that biological systems could be analyzed at various levels. 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 while 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

⁹(continued)

purposes, they are not the only useful ways of examining the layers of interlinked systems of human action.

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), Saussure (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 of the multiple levels 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. Modern formal theorists have not yet recognized how important a firm foundation of multiple levels of analysis is for work on the study of social institutions. One of the most creative and thoughtful modern analytical scholars, Charles Plott, for example, defined the fundamental equation of modern social choice theory to be a "one-level" equation. Using * as an unspecified abstract operation, Plott posed the following fundamental equation:

(1) preferences * institutions * physical possibilities = outcomes

Plott defined institutions as the "rules for individual expression, information transmittal, and social choice . . ." (1979: 156).

Instead of a single equation, I would reformulate Plott's equation as:

(1a) institutions * physical possibilities = structure of the situation

(1b) preferences * structure of the situation = outcomes

This two-equation system distinguishes between institutions viewed as the rules of a game and the game itself. While I do not agree with all of his analysis, Elkin (1985: 263) is attempting to break out of the conception of institutions as producing particular outcomes by stressing a "constitutive view" whereby one views institutions as creating a set of activities rather than producing a certain outcome. Institutions are considered to be "the rules of the game" and different from the game itself. I use a more general term -- the structure of a situation -- to refer to what game theorists call a game.

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 which will be produced by particular configurations of rules when used in combination with the physical laws of the system. 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 traditional literature in political philosophy to draw upon in developing a theory of rules, but little attention has been paid to this type of question in modern, social science literature.¹⁰ Further, considerable work in formal logic, particularly deontic logic, and in artificial intelligence, communications theory, socio-linguistics, 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 and form that particular rules take. 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, colleagues and I at the Workshop in Political Theory and Policy Analysis are developing a method to represent rules in a generic fashion by attempting to identify what is common to a set of specific rules and then capturing 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

¹⁰ There are important exceptions. In particular, see Buchanan and Tullock (1962), Shepsle (1979a; 1979b), V. Ostrom (1982; 1980; 1987, forthcoming), North (1981), and Hayami and Ruttan (1985).

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); and
- The rewards or penalties which may, must, or must not be assigned to actions or outcomes (payoff rules).¹¹

This is not the appropriate forum for a detailed examination of the methods we are developing for arraying generic rule configurations. Let me illustrate this evolving methodology, however, by concentrating on eight generic rules which were changed in West Basin; four of which were also changed in Alanya. While other rules are also involved in both cases, these eight rules were the focus of attention in West Basin when the participants attempted to restructure the situation they faced. A generic formulation of each of these eight rules is presented in Table 1.

[Table 1 About Here]

¹¹ See E. Ostrom (1986a; 1986b; 1986c) and Kiser and Ostrom (1982) for a 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.

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 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 on Table 1 were changed over a twenty year period.

By stating these rules in a generic, rather than specific form, it is now obvious that these eight rules were similar in Alanya and in West Basin in the "before" situation when participants were facing a Commons Dilemma. Without such reformulation, the similarity in underlying structure is hidden in the complexity of a modified riparian-like water rights doctrine and an open-access fishery regime. In our current research, we are examining the rule configurations underlying a series of cases similar to those described above to ascertain how similar generic rules are related to Commons' Dilemmas. From our early results, we know that the generic rule configurations underlying Commons 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. Further, 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 those which evolved in Törbel and in Harano (to take one of the Japanese villages as an example).

	Generic Rule Number									
	P1	E1	E2	A1	A2	R1	R2	R3	R4	
Törbel, Switzerland	Y	Y	N	Y	Y	Y	N	N	Y	
Harano, Japan	Y	Y	N	Y	Y	Y	N	N	Y	
Alanya, Turkey ("after")	Y	Y	N	Y	Y	Y	N	N	N	
West Basin, California ("after")	Y	N	Y	Y	Y	Y	Y	Y	N	

The eight rules we compared above can also be compared for all four success cases (the traditional systems which evolved in Törbel and in Harano and the "after" situations of Alanya and West Basin). I have added a ninth rule to this analysis (here labeled R4) which relates to whether payments are assessed on a per capita basis. I added this payoff rule, which was not changed in either the West Basin or the Alanya case, to make clear how participants in these two mountainous areas have been able to invest in improving the operation of their commons. While they do not have a use-tax (R2) or an assets tax (R3), which are both used in West Basin to gain resources to invest in the commons, they do assess each family unit (R4) to gain resources to

improve their commons. The fishermen in Alanya do not now use any of these forms of assessment. I predict, however, that if they do desire to enhance the supply side of their commons, they will turn to one of these three forms of assessment (R2, R3, or R4) to obtain the necessary resources for such efforts.

The similarity in the pattern for these nine rules for Törbel and Harano is striking. This portion of the rule configuration is identical for two systems which evolved in widely separated, fragile mountain regions in Switzerland and Japan.¹² Without transforming the particularities of the actual rules used in each of these settings into this more general form, this underlying similarity in structure would be difficult to establish. Although our work on generic rule formulation is still in progress, 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 focuses on how particular patterns in rules being used affect the structure of the situations humans confront. Analysis of these situations, in turn, looks at 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

¹² 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, 1986, forthcoming, for a more thorough description of these cases).

situations, the analysis of rules does not tell us how people will behave once rules have been changed (see Majone, 1986: 70).

* * * * *

A { There are several lessons that I hope you carry away from this lecture. First, the usefulness of an analytical device such as the Commons Dilemma should be apparent. } By examining the structure of the situation facing participants, we can identify the situational similarities facing water producers in West Basin and fishermen in Alanya before they were able to change the rules about how to act in those situations. The most important factors affecting their behavior were related to the structure of the Commons Dilemma and not such factors as the type of resource (water versus fish) or the location (California versus Turkey).

A { Second, I hope that we have dispelled a commonly held presumption that whenever individuals find themselves in a Commons Dilemma they are forever trapped in a tragedy of the commons. } While many factors, such as the size of the group and existence within a single nation, may enhance or detract from the capabilities of individuals to arrive at a way to restructure their own situations, we have examined four "success" stories where restructuring has occurred without an external imposition of a new order. Individuals clearly have the mental ability "to step outside" the confines of a given situation, devise solutions, and implement them. This should fortify our faith in the ability of humans to govern themselves.

A { Third, I hope we have dismantled another popular myth that there

is only one way to solve a Commons Dilemma. This myth does not survive close scrutiny since vocal advocates simultaneously extol the benefits of entirely different institutional solutions. Given that some analysts call for private market solutions as loudly as others call for central government solutions, considerable doubt is cast on the presumption that there is one best way to resolve a Commons Dilemma.¹³ The Swiss and Japanese villages, for instance, give us firm evidence that individuals who have had long experience with private land ownership do not find that arrangement to be the only way to organize productive relationships effectively. In these two cases, private ownership and communal ownership have existed side-by-side for centuries. Furthermore, none of our "success" stories have required strong central government intervention.

Finally, I have discussed the important methodological "lesson" that we cannot make much progress in the social sciences so long as we presume that most phenomena of interest occur at a single level. We need self-consciously to examine different levels of analysis and develop technical languages for work at these different levels. The relationships among levels must then be examined, but with a full recognition that there are different types of phenomena to be explained at each level. By understanding 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

¹³ Our case studies reveal, in addition, that there are possibilities for resolution of the Commons Dilemma that entail neither the imposition of Leviathan nor the privatization of all common resources.

social dilemmas. Human beings not only face choices about how to act in given situations, but they 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.

Table 1

Rules Which Were Changed in the Alanya or West Basin Cases

	"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

References

- Acheson, James M. (1975) "The Lobster Fiefs: Economic and Ecological Effects of Territoriality in the Maine Lobster Industry." Human Ecology, Vol. 3, No. 3, 183-207.
- Alchian, Armen and Harold Demsetz (1973) "The Property Rights Paradigm." Journal of Economic History, Vol. 33, No. 1 (March), 16-27.
- Axelrod, Robert (1981) "The Emergence of Cooperation Among Egoists." American Political Science Review, Vol. 75, No. 2 (June), 306-318.
- _____ (1984) The Evolution of Cooperation. New York: Basic Books.
- Bendor, Johnathan and Dilip Mookherjee (1985) "Institutional Structure and the Logic of Ongoing Collective Action." Working Paper. Palo Alto, California: Stanford University, School of Business.
- Berkes, Fikret (1985a) "The Common Property Resource Problem and the Creation of Limited Property Rights." Human Ecology, Vol. 13, No. 2 (June), 187-208.
- _____ (1985b) "Fisherman and 'The Tragedy of the Commons'." Environmental Conservation, Vol. 12, No. 3 (Autumn), 199-206.
- _____ (1985c) "Marine Inshore Fishery Management in Turkey: Some Examples, Problems and Prospects." Paper prepared for the Conference on Common Property Resource Management, sponsored by the Board on Science and Technology for International Development (BOSTID), National Academy of Sciences, National Research Council, Annapolis, Maryland, April 21-26.
- _____ and Dorothy Pocock (1981) "Self-Regulation of Commercial Fisheries of the Outer Log Point Bay, Lake Erie." Journal of Great Lakes Research, Vol. 1, No. 2, 111-116.
- Blomquist, William and Elinor Ostrom (1985) "Institutional Capacity and the Resolution of a Commons Dilemma." Policy Studies Review, Vol. 5, No. 2 (November), 383-393.
- Braybrooke, David (1985) "The Insoluble Problem of the Social Contract." In Richmond Campbell and Lanning Sowden, eds. Paradoxes of Rationality and Cooperation. Vancouver: University of British Columbia Press, 277-305.
- Buchanan, James and Gordon Tullock (1962) The Calculus of Consent: Logical Foundations of Constitutional Democracy. Ann Arbor: University of Michigan Press.

- Bullock, Kari and John Baden (1977) "Communes and the Logic of the Commons." In Garrett Hardin and John Baden, eds. Managing the Commons. San Francisco: W. H. Freeman, 182-199.
- Campbell, Richmond (1985) "Background for the Uninitiated." In Richmond Campbell and Lanning Sowden, eds. Paradoxes of Rationality and Cooperation. Vancouver: University of British Columbia Press, 3-41.
- Carruthers, Ian and Roy Stoner (1981) Economic Aspects and Policy Issues in Groundwater Development. World Bank Staff Working Paper No. 496. Washington, D.C.: The World Bank.
- Cave, Jonathan A.K. (1984) The Cold Fish War: Long-Term Competition in a Dynamic Game. Santa Monica, California: Rand Corporation.
- Chomsky, Noam (1965) Aspects of the Theory of Syntax. Cambridge, MA: The M.I.T. Press.
- _____ (1975) Reflections on Language. New York: Random House.
- _____ (1978) Rules and Representation. New York: Columbia University Press.
- Cordell, John (1985) "Sea Tenure in Bahia." Paper prepared for the Conference on Common Property Resource Management, sponsored by the Board on Science and Technology for International Development (BOSTID), National Academy of Sciences, National Research Council, Annapolis, Maryland, April 21-26.
- Courtois, P. J. (1985) "On Time and Space Decomposition of Complex Structures." Communications of the ACM, Vol. 28, No. 6 (June), 590-603.
- Cruz, Wilfrido (1985) "Over-Fishing and Conflict in a Traditional Fishery: A Resource Management Dilemma." Paper prepared for the Conference on Common Property Resource Management, sponsored by the Board on Science and Technology for International Development (BOSTID), National Academy of Sciences, National Research Council, Annapolis, Maryland, April 21-26.
- Davis, Anthony (1984) "Property Rights and Access Management in the Small Boat Fishery: A Case Study from Southwest Nova Scotia." In Cynthia Lamson and Arthur J. Hanson, eds. Atlantic Fisheries and Coastal Communities: Fisheries Decision-Making Case Studies. Halifax: Dalhousie Ocean Studies Programme, 133-164.
- Dawes, Robyn M. (1973) "The Commons Dilemma Game: An N-Person Mixed-Motive Game with a Dominating Strategy for Defection." ORI Research Bulletin, Vol. 13, No. 2 (September), 1-12.
- _____ (1975) "Formal Models of Dilemmas in Social Decision Making." In Martin F. Kaplan and Steven Schwartz, eds. Human Judgment and Decision Processes: Formal and Mathematical Approaches. New York: Academic Press.

- Dawes, Robyn M., Jeanne McTavish, and Harriet Shaklee (1977) "Behavior, Communication, and Assumptions About Other People's Behavior in a Commons Dilemma Situation." Journal of Personality and Social Psychology, Vol. 35, No. 1 (January), 1-11.
- DeAlessi, Louis (1980) "The Economics of Property Rights: A Review of the Evidence." Research in Law and Economics, Vol. 2, 1-47.
- Demsetz, Harold (1967) "Toward a Theory of Property Rights." American Economics Review, Vol. 62, No. 2 (May), 347-359.
- Ehrenfeld, David W. (1972) Conserving Life on Earth. New York: Oxford University Press.
- Elkin, Stephen L. (1985) "Economic and Political Rationality." Polity, Vol 18, No. 2 (Winter), 253-271.
- Feeny, David (1982) The Political Economy of Productivity: Thai Agricultural Development 1880-1975. Vancouver: University of British Columbia Press.
- _____ (1986) "Where Do We Go From Here?: Observations on the Implications for the Research Agenda." Paper prepared for the Panel on Common Property Resource Management of the Board on Science and Technology for International Development (BOSTID), National Academy of Sciences/National Research Council.
- Giddons, Anthony (1979) Central Problems in Social Theory: Action, Structure and Contradiction in Social Analysis. Berkeley: University of California Press.
- Godwin, Kenneth and W. Bruce Shepard (1979) "Forcing Squares, Triangles and Ellipses into a Circular Paradigm: The Use of the Commons Dilemma in Examining the Allocation of Common Resources." Western Political Quarterly, Vol, 32, No. 3 (September), 265-277.
- Gordon, H. Scott (1954) "The Economic Theory of a Common-Property Resource: The Fishery." Journal of Political Economy, Vol. 62, No. 2 (April), 124-142.
- Grofman, Bernard and Jonathan Pool (1975) "Bayesian Models for Iterated Prisoner's Dilemma Games." General Systems, Vol. 20, 185-194.
- Guth, Werner (1985) "An Extensive Game Approach to Modelling the Nuclear Deterrence Debate." Zeitschrift für die gesamte Staatswissenschaft, Vol. 141, 525-538.
- Hardin, Garrett (1968) "The Tragedy of the Commons." Science, Vol. 162 (December), 1,243-1,248.
- _____ (1978) "Political Requirements for Preserving our Common Heritage." In Howard P. Brokaw, ed. Wildlife and America. Washington, D.C.: Council on Environmental Quality, 310-317.

- Hardin, Russell (1982) Collective Action. Baltimore: Johns Hopkins University Press.
- Hayami, Yujiro and Vernon Ruttan (1985) Agricultural Development: An International Perspective. Baltimore: Johns Hopkins University Press.
- Heilbroner, Robert L. (1974) An Inquiry Into the Human Prospect. New York: Norton.
- Hofstadter, Douglas R. (1979) Gödel, Escher, Bach: An Eternal Golden Braid. New York: Basic Books.
- Humboldt, Wilhelm von (1836) Über die Verschiedenheit des Menschlichen Sprachbaues. Berlin: Druckerei der Königlichen Akademie der Wissenschaften.
- Kimber, Richard (1981) "Collective Action and the Fallacy of the Liberal Fallacy." World Politics, Vol. 33, No. 2 (January), 178-196.
- Kiser, Larry 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 Publications, 179-222.
- Knapp, Keith and H. J. Vaux (1982) "Barriers to Effective Ground-Water Management: The California Case." Groundwater, Vol. 20, No. 1 (January/February), 61-66.
- Lewis, Tracy R. and James Cowens (1983) "Cooperation in the Commons: An Application of Repetitious Rivalry." Vancouver: University of British Columbia, Department of Economics.
- Lloyd, William F. (1977) "On the Checks to Population." In Garrett Hardin and John Baden, eds. Managing the Commons. San Francisco: W. H. Freeman.
- Luce, R. Duncan and Howard Raiffa (1957) Games and Decisions: Introduction and Critical Survey. New York: John Wiley.
- Lumsden, Malvern (1973) "The Cyprus Conflict as a Prisoner's Dilemma." Journal of Conflict Resolution, Vol. 17, No. 1 (March), 7-32.
- Magnusson, David, ed. (1981) Toward a Psychology of Situations: An Interactional Perspective. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.
- Majone, Giandomenico (1986) "Policy Science." In F. X. Kaufmann, G. Majone, and V. Ostrom, eds. Guidance, Control, and Evaluation in the Public Sector. Berlin and New York: Walter de Gruyter, 61-70.

- McCay, Bonnie J. (1980) "A Fishermans Cooperative: Indigenous Resource Management in a Complex Society." Anthropological Quarterly, Vol. 53, No. 1 (January), 29-38.
- _____ and James M. Acheson, eds. (1986) Capturing the Commons. Tuscon: University of Arizona Press, forthcoming.
- McKean, Margaret A. (1984) "Management of Traditional Common Lands (iriaiichi) in Japan." Paper prepared for the Panel on Common Property Resource Management of the Board on Science and Technology for International Development (BOSTID), National Academy of Sciences/National Research Council.
- Neher, P. A. (1978) "The Pure Theory of the Muggery." American Economics Review, Vol. 68, No. 3 (June), 437-445.
- Netting, Robert McC. (1976) "What Alpine Peasants Have in Common: Observations on Communal Tenure in a Swiss Village." Human Ecology, Vol. 4, No. 2 (June), 135-146.
- North, Douglass C. (1981) Structure and Change in Economic History. New York: Norton.
- Oakerson, Ronald J. (1984) "A Model for the Analysis of Common Property Relations." Paper prepared for the Common Property Steering Committee, Board on Science and Technology for International Development (BOSTID), National Academy of Sciences/National Research Council.
- Ophuls, William (1973) "Leviathan or Oblivion." In Herman E. Daley, ed. Toward a Steady State Economy. San Francisco: W. H. Freeman.
- Orbell, John M. and L. A. Wilson (1978) "Institutional Solutions to the N-Prisoners' Dilemma." American Political Science Review, Vol. 72, No. 2 (June), 411-421.
- Ostrom, Elinor (1965) "Public Entrepreneurship: A Case Study in Ground Water Management." Ph.D. Dissertation. Los Angeles: University of California at Los Angeles, Department of Political Science.
- _____ (1986a) "An Agenda for the Study of Institutions." Public Choice, Vol. 48, 3-25.
- _____ (1986b) "Institutional Arrangements for Resolving the Commons Dilemma: Some Contending Approaches." In Bonnie J. McCay and James Acheson, eds. Capturing the Commons. Tucson: University of Arizona Press, forthcoming.
- _____ (1986c) "A Method of Institutional Analysis." In F. X. Kaufmann, G. Majone, and V. Ostrom, eds. Guidance, Control, and Evaluation in the Public Sector. Berlin and New York: Walter de Gruyter, 459-475.

Ostrom, Elinor (1986d) "Multiorganizational Arrangements and Coordination: An Application of Institutional Analysis." In F. X. Kaufmann, G. Majone, and V. Ostrom, eds. Guidance, Control, and Evaluation in the Public Sector. Berlin and New York: Walter de Gruyter, 459-475.

Ostrom, Vincent (1980) "Artisanship and Artifact." Public Administration Review, Vol. 40, No. 4 (July/August), 309-317.

_____ (1982) "A Forgotten Tradition: The Constitutional Level of Analysis." In Judith A. Gillespie and Dina A. Zinnes, eds. Missing Elements in Political Inquiry: Logic and Levels of Analysis. Beverly Hills: Sage Publications, 237-252.

_____ (1985a) "The Constitution of Order in Human Societies: Conceptualizing the Nature and Magnitude of the Task in Institutional Analysis and Development." Paper presented at the International Political Science Association meetings, Paris, July 15-20.

_____ (1985b) "Opportunity, Diversity, and Complexity." Presented at Conference on Multi-Actor Policy Analysis: The Scope and Direction of Policy Recommendations, University of Umea, Sweden, July 23-25.

_____ (1987) The Logic of a Compound Republic: Designing a Political Experiment. Lincoln, Nebraska: University of Nebraska Press, forthcoming.

Picardi, A. C. and W. W. Seifert (1977) "A Tragedy of the Commons in the Sahel." Ekistics, Vol. 43 (May), 297-304.

Plott, Charles R. (1979) "The Application of Laboratory Experimental Methods to Public Choice." In Clifford S. Russell, ed. Collective Decision Making: Applications from Public Choice Theory. Baltimore: Johns Hopkins University Press, 137-160.

Prigogine, Ilya (1978) "Time, Structure, and Fluctuations." Science, Vol. 201, No. 4358 (September), 777-785.

Rapoport, Anatol (1966) Two-Person Game Theory. The Essential Ideas. Ann Arbor: University of Michigan Press.

_____ and A. M. Chammah (1965) Prisoner's Dilemma: A Study in Conflict and Cooperation. Ann Arbor: University of Michigan Press.

Rolph, E. (1982) "Government Allocation of Property Rights: Why and How." Technical Report. Santa Monica, California: Rand Corporation.

Rose-Ackerman, Susan (1977) "Market Models for Water Pollution Control: Their Strengths and Weaknesses." Public Policy, Vol. 25, No. 3 (Summer), 383-406.

- de Saussure, Ferdinand (1960) Course in General Linguistics. London: Peter Owen.
- Scharpf, Fritz W. (1985) "Ideological Conflict on the Public-Private Frontier: Some Exploratory Notes." Working Paper. Berlin: Wissenschaftszentrum.
- Searle, John (1969) Speech Acts: An Essay in the Philosophy of Language. New York: Cambridge University Press.
- Selten, Reinhard (1975) "Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games." International Journal of Game Theory, Vol. 4, 25-55.
- _____ (1978) "The Chain Store Paradox." Theory and Decision, Vol. 9, No. 2 (April), 127-159.
- Shepsle, Kenneth A. (1979a) "Institutional Arrangements and Equilibrium in Multidimensional Voting Models." American Journal of Political Science, Vol. 23, No. 1 (February), 27-59.
- _____ (1979b) "The Role of Institutional Structure in the Creation of Policy Equilibrium." In Douglas W. Rae and Theodore J. Eismeyer, eds. Public Policy and Public Choice. Sage Yearbooks in Politics and Public Policy, Vol. 6. Beverly Hills: Sage Publications, 249-283.
- _____ and Barry Weingast (1984) "Legislative Politics and Budget Outcomes." In G. Mills and J. Palmer, eds. Federal Budget Policy in the 1980's. Washington, D.C.: Urban Institute Press, 343-367.
- Shubik, Martin (1982) Game Theory in the Social Sciences. Concepts and Solutions. Cambridge, Massachusetts: MIT Press, Volumes 1 and 2.
- Siy, Robert Y., Jr. (1982) Community Resources Management: Lessons from the Zanjera. Quezon City, Philippines: University of the Philippines Press.
- Smith, Robert J. (1981) "Resolving the Tragedy of the Commons by Creating Private Property Rights in Wildlife." CATO Journal, Vol. 1, No. 2 (Fall), 439-468.
- Snidal, Duncan (1985) "Coordination Versus Prisoners' Dilemma: Implications for International Cooperation and Regimes." American Political Science Review, Vol. 79, No. 4 (December), 923-942.
- Sobel, Jordan Howard (1985) "Utility Maximizers in Iterated Prisoner's Dilemmas." In Richmond Campbell and Lanning Sowden, eds. Paradoxes of Rationality and Cooperation. Vancouver: University of British Columbia Press, 306-319.

- Stillman, Peter G. (1975) "The Tragedy of the Commons: A Reanalysis." Alternatives, Vol. 4, No. 2, 12-15.
- Ullmann-Margalit, Edna (1977) The Emergence of Norms. New York: Oxford University Press.
- Uphoff, Norman (1985) "People's Participation in Water Management: Gal Oya, Sri Lanka." In Jean Claude Garcia-Zamor, ed. Public Participation in Development Planning and Management: Cases from Africa and Asia. Boulder, Colorado: Westview Press, 131-178.
- van de Kragt, Alphons J. C., John M. Orbell, and Robyn M. Dawes (1983) "The Minimal Contributing Set as a Solution to Public Goods Problems." American Political Science Review, Vol. 77, No. 1, 112-122.
- Wade, Robert (1985) "Common Property Resource Management in South Indian Villages." Paper prepared for the Conference on Common Property Resource Management, sponsored by the Board on Science and Technology for International Development (BOSTID), National Academy of Sciences, National Research Council, Annapolis, Maryland, April 21-26.
- _____ (1987) Peasants and Politics. Cambridge: University of Cambridge Press, forthcoming.
- Welch, W. P. (1983) "The Political Feasibility of Full Ownership Property Rights: The Cases of Pollution and Fisheries." Policy Sciences, Vol. 16, No. 2 (November), 165-180.
- Weschler, Louis F. (1968) Water Resources Management: The Orange County Experience. California Government Series No. 14. Davis, California: University of California, Institute of Governmental Affairs.
- Wiegandt, E. B. (1977) "Communalism and Conflict in the Swiss Alps." Ph.D. Dissertation. Ann Arbor: University of Michigan.
- Wilson, John (1986) "Subjective Probability and the Prisoner's Dilemma." Management Sciences, Vol. 32, No. 1 (January), 45-55.
- Wilson, Rick K. (1985) "Constraints on Social Dilemmas: An Institutional Approach." Annals of Operations Research, Vol. 2, 183-200.
- Wittgenstein, Ludwig (1953) Philosophical Investigations. Oxford: Basil Blackwell and Mott.