

THE POLITICAL ECONOMY OF INSTITUTIONS AND DECISIONS

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GOVERNING THE COMMONS

*The evolution of institutions
for collective action*

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GOVERNING THE COMMONS

Preface

can better search out variables from what we are reading and gathering. The help of Elizabeth Case, associate editor for this series, Sophia Prybylski at Cambridge University Press, and Emily Loose, editor at Cambridge University Press, is gratefully acknowledged. Patty Dalecki has, as always, provided professional editorial and production support that has greatly improved the quality of the manuscript. Her cheerful spirit has relieved pressures on many occasions.

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Reflections on the commons

Hardly a week goes by without a major news story about the threatened destruction of a valuable natural resource. In June of 1989, for example, a *New York Times* article focused on the problem of overfishing in the Georges Bank about 150 miles off the New England coast. Catches of cod, flounder, and haddock are now only a quarter of what they were during the 1960s. Everyone knows that the basic problem is overfishing; however, those concerned cannot agree how to solve the problem. Congressional representatives recommend new national legislation, even though the legislation already on the books has been enforced only erratically. Representatives of the fishers argue that the fishing grounds would not be in such bad shape if the federal government had refrained from its sporadic attempts to regulate the fishery in the past. The issue in this case – and many others – is how best to limit the use of natural resources so as to ensure their long-term economic viability. Advocates of central regulation, of privatization, and of regulation by those involved have pressed their policy prescriptions in a variety of different arenas.

Similar situations occur on diverse scales ranging from small neighborhoods to the entire planet. The issues of how best to govern natural resources used by many individuals in common are no more settled in academia than in the world of politics. Some scholarly articles about the “tragedy of the commons” recommend that “the state” control most natural resources to prevent their destruction; others recommend that privatizing those resources will resolve the problem. What one can observe in the world, however, is that neither the state nor the market is uniformly successful in enabling individuals to sustain long-term, productive use of natural resource systems. Further, communities of individuals have relied on institutions resembling neither the state nor the market to govern some resource systems with reasonable degrees of success over long periods of time.

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We do not yet have the necessary intellectual tools or models to understand the array of problems that are associated with governing and managing natural resource systems and the reasons why some institutions seem to work in some settings and not others. This book is an effort to (1) critique the foundations of policy analysis as applied to many natural resources, (2) present empirical examples of successful and unsuccessful efforts to govern and manage such resources, and (3) begin the effort to develop better intellectual tools to understand the capabilities and limitations of self-governing institutions for regulating many types of resources. To do this, I first describe the three models most frequently used to provide a foundation for recommending state or market solutions. I then pose theoretical and empirical alternatives to these models to begin to illustrate the diversity of solutions that go beyond states and markets. Using an institutional mode of analysis, I then attempt to explain how communities of individuals fashion different ways of governing the commons.

THREE INFLUENTIAL MODELS

The tragedy of the commons

Since Garrett Hardin's challenging 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 use a scarce resource in common. To illustrate the logical structure of his model, 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 herder. Each herder receives a direct benefit from his own animals and suffers delayed costs from the deterioration of the commons when his and others' cattle overgraze. Each herder 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, p. 1,244)

Hardin was not the first to notice the tragedy of the commons. Aristotle 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). Hobbes's parable of man in a state of nature is a prototype of the tragedy of the commons: Men

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seek their own good and end up fighting one another. In 1833, William Forster Lloyd (1977) sketched a theory of the commons that predicted improvident use for property owned in common. More than a decade before Hardin's article, H. Scott Gordon (1954) clearly expounded similar logic in another classic: "The Economic Theory of a Common-Property Resource: The Fishery." Gordon described the same dynamic as Hardin:

There appears then, to be some truth in the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by no one because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another. . . . The fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today. (Gordon 1954, p. 124)

John H. Dales (1968, p. 62) noted at the same time the perplexing problems related to resources "owned in common because there is no alternative!" Standard analyses in modern resource economics conclude that where a number of users have access to a common-pool resource, the total of resource units withdrawn from the resource will be greater than the optimal economic level of withdrawal (Clark 1976, 1980; Dasgupta and Heal 1979).

If the only "commons" of importance were a few grazing areas or fisheries, the tragedy of the commons would be of little general interest. That 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), firewood crises throughout the Third World (Norman 1984; Thomson 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 capacity to overspend (Shepsle and Weingast 1984), urban crime (Neher 1978), public-sector/private-sector relationships in modern economies (Scharpf 1985, 1987, 1988), the problems of international cooperation (Snidal 1985), and communal conflict in Cyprus (Lumsden 1973). Much of the world is dependent on resources that are subject to the possibility of a tragedy of the commons.

The prisoner's dilemma game

Hardin's model has often been formalized as a prisoner's dilemma (PD) game (Dawes 1973, 1975).¹ Suppose we think of the players in a game as being herders using a common grazing meadow. For this meadow, there is an upper limit to the number of animals that can graze on the meadow for

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a season and be well fed at the end of the season. We call that number L . For a two-person game, the "cooperate" strategy can be thought of as grazing $L/2$ animals for each herder. The "defect" strategy is for each herder to graze as many animals as he thinks he can sell at a profit (given his private costs), assuming that this number is greater than $L/2$. If both herders limit their grazing to $L/2$, they will obtain 10 units of profit, whereas if they both choose the defect strategy they will obtain zero profit. If one of them limits his number of animals to $L/2$, while the other grazes as many as he wants, the "defector" obtains 11 units of profit, and the "sucker" obtains -1. If each chooses independently without the capacity to engage in a binding contract, each chooses his dominant strategy, which is to defect. When they both defect, they obtain zero profit. Call this the Hardin herder game, or Game 1. It has the structure of a prisoner's dilemma game.²

The prisoner's dilemma game is conceptualized as a noncooperative game in which all players possess complete information. In noncooperative games, communication among the players is forbidden or impossible or simply irrelevant as long as it is not explicitly modeled as part of the game. If communication is possible, verbal agreements among players are presumed to be nonbinding unless the possibility of binding agreements is explicitly incorporated in the game structure (Harsanyi and Selten 1988, p. 3). "Complete information" implies that all players know the full structure of the game tree and the payoffs attached to outcomes. Players either know or do not know the current moves of other players depending on whether or not they are observable.

In a prisoner's dilemma game, each player has a dominant strategy in the sense that the player is always better off choosing this strategy – to defect

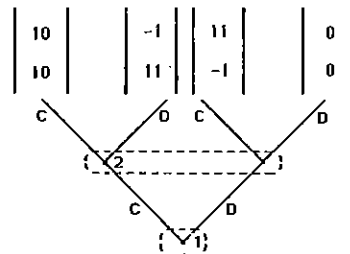


Figure 1.1. Game 1: The Hardin herder game.

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– no matter what the other player chooses. When both players choose their dominant strategy, given these assumptions, they produce an equilibrium that is the third-best result for both. Neither has an incentive to change that is independent of the strategy choice of the other. The equilibrium resulting from each player selecting his or her "best" individual strategy is, however, not a Pareto-optimal outcome. A Pareto-optimal outcome occurs when there is no other outcome strictly preferred by at least one player that is at least as good for the others. In the two-person prisoner's dilemma game, both players prefer the (cooperate, cooperate) outcome to the (defect, defect) outcome. Thus, the equilibrium outcome is Pareto-inferior.

The prisoner's dilemma game fascinates 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 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, p. 3)

The deep attraction of the dilemma is further illustrated by the number of articles written about it. At one count, 15 years ago, more than 2,000 papers had been devoted to the prisoner's dilemma game (Grofman and Pool 1975).

The logic of collective action

A closely related view of the difficulty of getting individuals to pursue their joint welfare, as contrasted to individual welfare, was developed by Mancur Olson (1965) in *The Logic of Collective Action*. Olson specifically set out to challenge the grand optimism expressed in group theory: that individuals with common interests would voluntarily act so as to try to further those interests (Bentley 1949; Truman 1958). On the first page of his book, Olson summarized that accepted view:

The idea that groups tend to act in support of their group interests is supposed to follow logically from this widely accepted premise of rational, self-interested behavior. In other words, if the members of some group have a common interest or object, and if they would all be better off if that objective were achieved, it has been

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thought to follow logically that the individuals in that group would, if they were rational and self-interested, act to achieve that objective. (Olson 1965, p.1)

Olson challenged the presumption that the possibility of a benefit for a group would be sufficient to generate collective action to achieve that benefit. In the most frequently quoted passage of his book, Olson argued that

unless the number of individuals is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, *rational, self-interested individuals will not act to achieve their common or group interests.* (Olson 1965, p. 2; emphasis in original)

Olson's argument rests largely on the premise that one who cannot be excluded from obtaining the benefits of a collective good once the good is produced has little incentive to contribute voluntarily to the provision of that good. His book is less pessimistic than it is asserted to be by many who cite this famous passage. Olson considers it an open question whether intermediate-size groups will or will not voluntarily provide collective benefits. His definition of an intermediate-size group depends not on the number of actors involved but on how noticeable each person's actions are.

The tragedy of the commons, the prisoner's dilemma, and the logic of collective action are closely related concepts in the models that have defined the accepted way of viewing many problems that individuals face when attempting to achieve collective benefits. At the heart of each of these models is the free-rider problem. Whenever one person cannot be excluded from the benefits that others provide, each person is motivated not to contribute to the joint effort, but to free-ride on the efforts of others. If all participants choose to free-ride, the collective benefit will not be produced. The temptation to free-ride, however, may dominate the decision process, and thus all will end up where no one wanted to be. Alternatively, some may provide while others free-ride, leading to less than the optimal level of provision of the collective benefit. These models are thus extremely useful for explaining how perfectly rational individuals can produce, under some circumstances, outcomes that are not "rational" when viewed from the perspective of all those involved.

What makes these models so interesting and so powerful is that they capture important aspects of many different problems that occur in diverse settings in all parts of the world. What makes these models so dangerous – when they are used metaphorically as the foundation for policy – is that the constraints that are assumed to be fixed for the purpose of analysis are taken on faith as being fixed in empirical settings, unless external author-

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ities change them.³ The prisoners in the famous dilemma cannot change the constraints imposed on them by the district attorney; they are in jail. Not all users of natural resources are similarly incapable of changing their constraints. As long as individuals are viewed as prisoners, policy prescriptions will address this metaphor. I would rather address the question of how to enhance the capabilities of those involved to change the constraining rules of the game to lead to outcomes other than remorseless tragedies.

THE METAPHORICAL USE OF MODELS

These three models and their many variants are diverse representations of a broader and still-evolving theory of collective action. Much more work will be needed to develop the theory of collective action into a reliable and useful foundation for policy analysis. Considerable progress has been made during the past three decades by theorists and empirically oriented social scientists. The sweeping conclusions of the first variants of this theory have given way to a more qualified body of knowledge involving many more variables and explicit base conditions.

As an evolving, rather than completed, theory, it provokes disagreement regarding the importance or insignificance of some variables and how best to specify key relationships.⁴ The results from more recent work, particularly work focusing on the dynamic aspects of relevant empirical settings, have begun to generate more optimistic predictions than did earlier models; see, in particular, the work of Axelrod (1981, 1984) and Kreps and Wilson (1982). This is one of the most exciting areas in the social sciences, for although considerable cumulation has already occurred, some deep questions remain unanswered. Some of these puzzles are key to understanding how individuals jointly using a common-pool resource might be able to achieve an effective form of governing and managing their own commons. These puzzles are examined in Chapter 2.

Much that has been written about common-pool resources, however, has uncritically accepted the earlier models and the presumption of a remorseless tragedy (Nebel 1987). Scholars have gone so far as to recommend that "Hardin's 'Tragedy of the Commons' should be required reading for all students . . . and, if I had my way, for all human beings."⁵ Policy prescriptions have relied to a large extent on one of the three original models, but those attempting to use these models as the basis for policy prescription frequently have achieved little more than a metaphorical use of the models.

When models are used as metaphors, an author usually points to the similarity between one or two variables in a natural setting and one or two

variables in a model. If calling attention to similarities is all that is intended by the metaphor, it serves the usual purpose of rapidly conveying information in graphic form. These three models have frequently been used metaphorically, however, for another purpose. The similarity between the many individuals jointly using a resource in a natural setting and the many individuals jointly producing a suboptimal result in the model has been used to convey a sense that further similarities are present. By referring to natural settings as "tragedies of the commons," "collective-action problems," "prisoner's dilemmas," "open-access resources," or even "common-property resources," the observer frequently wishes to invoke an image of helpless individuals caught in an inexorable process of destroying their own resources. An article in the December 10, 1988, issue of *The Economist* goes so far as to assert that fisheries can be managed successfully only if it is recognized that "left to their own devices, fisherman will overexploit stocks," and "to avoid disaster, managers must have effective hegemony over them."

Public officials sometimes do no more than evoke grim images by briefly alluding to the popularized versions of the models, presuming, as self-evident, that the same processes occur in all natural settings. The Canadian minister of fisheries and oceans, for example, captured the color of the models in a 1980 speech:

If you let loose that kind of economic self-interest in fisheries, with everybody fishing as he wants, taking from a resource that belongs to no individual, you end up destroying your neighbour and yourself. In free fisheries, good times create bad times, attracting more and more boats to chase fewer and fewer fish, producing less and less money to divide among more and more people.

(Romeo LeBlanc, speaking at the 50th anniversary meeting of the United Maritime Fishermen, March 19, 1980; quoted by Matthews and Phyne 1988)

The implication, of course, was that Canadian fisheries universally met that description – an empirically incorrect inference.⁶ But many observers have come to assume that most resources are like those specified in the three models. As such, it has been assumed that the individuals have been caught in a grim trap. The resulting policy recommendations have had an equally grim character.

CURRENT POLICY PRESCRIPTIONS

Leviathan as the "only" way

Ophuls (1973, p. 228) argued, for example, that "because of the tragedy of the commons, environmental problems cannot be solved through co-operation... and the rationale for government with major coercive

powers is overwhelming." Ophuls concluded that "even if we avoid the tragedy of the commons, it will *only* be by recourse to the tragic necessity of Leviathan" (1973, p. 229; emphasis added).⁷ Garrett Hardin 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, p. 310). The "cloud of ignorance" did not, however, prevent him from presuming that the only alternatives to the commons dilemma were what he called "a private enterprise system," on the one hand, or "socialism," on the other (1978, p. 314). With the assurance of one convinced that "the alternative of the commons is too horrifying to contemplate" (1968, p. 1,247), Hardin indicated that change would have to be instituted with "whatever force may be required to make the change stick" (1978, p. 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" (Hardin 1978, p. 314).

The presumption that an external Leviathan is necessary to avoid tragedies of the commons leads to recommendations that central governments control most natural resource systems. Heilbroner (1974) opined that "iron governments," perhaps military governments, would be necessary to achieve control over ecological problems. In a less draconian view, Ehrenfeld (1972, p. 322) suggested that if "private interests cannot be expected to protect the public domain then external regulation by public agencies, governments, or international authorities is needed." In an analysis of the problems involved in water resource management in developing countries, Carruthers and Stoner (1981, p. 29) argued that without public control, "overgrazing and soil erosion of communal pastures, or less fish at higher average cost," would result. They concluded that "common property resources *require* public control if economic efficiency is to result from their development" (1981, p. 29; emphasis added).⁸ The policy advice to centralize the control and regulation of natural resources, such as grazing lands, forests, and fisheries, has been followed extensively, particularly in Third World countries.

One way to illustrate these proponents' image of centralized control is to modify the Hardin herder game using the assumptions that underlie this policy advice. The proponents of centralized control want an external government agency to decide the specific herding strategy that the central authority considers best for the situation: The central authority will decide who can use the meadow, when they can use it, and how many animals can be grazed. Let us assume that the central authority decides to impose a penalty of 2 profit units on anyone who is considered by that authority to

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be using a defect strategy. Assuming that the central agency knows the sustainable yield of the meadow (L) and can unfailingly discover and penalize any herder using the defect strategy, the newly restructured game imposed by the central authority is represented in Game 2. Now, the solution to Game 2 is (cooperate, cooperate). Both players receive 10 profit units each, rather than the zero units they would have received in Game 1. If an external authority accurately determines the capacity of a common-pool resource, unambiguously assigns this capacity, monitors actions, and unfailingly sanctions noncompliance, then a centralized agency can transform the Hardin herder game to generate an optimally efficient equilibrium for the herders. Little consideration is given to the cost of creating and maintaining such an agency. This is seen as exogenous to the problem and is not included as a parameter of Game 2.⁹

The optimal equilibrium achieved by following the advice to centralize control, however, is based on assumptions concerning the accuracy of information, monitoring capabilities, sanctioning reliability, and zero costs of administration. Without valid and reliable information, a central agency could make several errors, including setting the carrying capacity or the fine too high or too low, sanctioning herders who cooperate, or not sanctioning defectors. The implications of all forms of incomplete information are interesting. However, as an example, I shall focus entirely on the implications arising from a central agency's incomplete information about the herders' strategies. The implicit assumption of Game 2 is that the central agency monitors all actions of the herders costlessly and imposes sanctions correctly.

In Game 3, we assume that the central agency has complete information about the carrying capacity of the meadow, but incomplete information about the particular actions of the herders. The central agency conse-

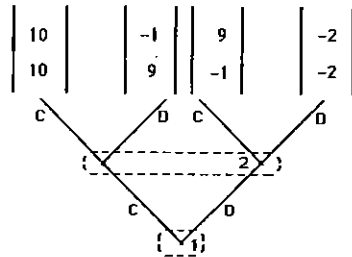


Figure 1.2. Game 2: The central-authority game with complete information.

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quently makes errors in imposing punishments. Let us assume that the central agency punishes defections (the correct response) with probability y and fails to punish defections with probability $1 - y$ (the erroneous response). Let us also assume that the central agency punishes cooperative actions (the erroneous response) with probability x and does not punish cooperative actions (the correct response) with probability $1 - x$. The payoff parameters are illustrated in Figure 1.3.

A central agency with complete information would make no errors in its punishment level; in that case, $x = 0$ and $y = 1$. Game 2 would then be a special case of Game 3 in which $x = 0$ and $y = 1$. However, if the central agency does not have complete information about the actions of the herders, it imposes both types of sanctions correctly with a probability of 0.7 ($x = 0.3$, $y = 0.7$). An example of the specific payoffs for this game is shown as Game 4 in Figure 1.4. Given this payoff structure, the herders again face a prisoner's dilemma game. They will defect (overgraze) rather than cooperate (graze within the carrying capacity). In Game 4, as in the original Game 1, the equilibrium outcomes for the herders were (0, 0). In a game in which a central agency sanctions correctly with a probability of 0.7, the equilibrium outcomes are $(-1.4, -1.4)$. The equilibrium of the regulated game has a lower value than that of the unregulated game. Given the carrying capacity and profit possibilities of Game 1, the central agency must have sufficient information so that it can correctly impose sanctions with a probability greater than 0.75 to avoid pushing the herders to the (D, D) equilibrium.¹⁰

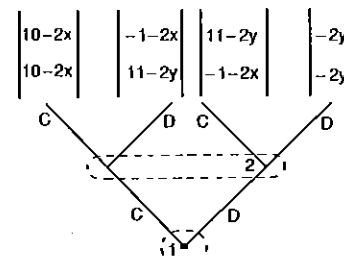


Figure 1.3. Game 3: The central-authority game with incomplete information.

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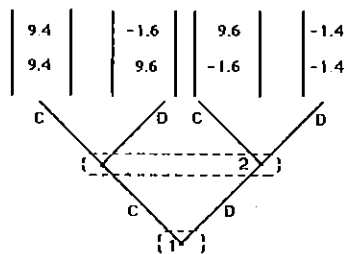


Figure 1.4. Game 4: An example of the central-authority game with incomplete information.

Privatization as the "only" way

Other policy analysts, influenced by the same models, have used equally strong terms in calling for the imposition of private property rights whenever resources are owned in common (Demsetz 1967; O. Johnson 1972). "Both the economic analysis of common property resources and Hardin's treatment of the tragedy of the commons" led Robert J. Smith (1981, p. 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" (emphasis added); see also the work of Sinn (1984). Smith stressed that it is "by treating a resource as a common property that we become locked in its inexorable destruction" (1981, p. 465). Welch advocated the creation of full private rights to a commons when he asserted that "the establishment of full property rights is necessary to avoid the inefficiency of overgrazing" (1983, p. 171). He asserted that privatization of the commons was the optimal solution for all common-pool problems. His major concern was how to impose private ownership when those currently using a commons were unwilling to change to a set of private rights to the commons.

Those recommending the imposition of privatization on the herders would divide the meadow in half and assign half of the meadow to one herder and the other half to the second herder. Now each herder will be playing a *game against nature* in a smaller terrain, rather than a game against another player in a larger terrain. The herders now will need to invest in fences and their maintenance, as well as in monitoring and sanctioning activities to enforce their division of the grazing area (B. Field 1984, 1985b). It is presumed that each herder will now choose $X/2$ animals

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to graze as a result of his own profit incentive.¹¹ This assumes that the meadow is perfectly homogeneous over time in its distribution of available fodder. If rainfall occurs erratically, one part of the grazing area may be lush with growth one year, whereas another part of the area may be unable to support $X/2$ animals. The rain may fall somewhere else the next year. In any given year, one of the herders may make no profit, and the other may enjoy a considerable return. If the location of lush growth changes dramatically from year to year, dividing the commons may impoverish both herders and lead to overgrazing in those parts where forage is temporarily inadequate. Of course, it will be possible for the herder who has extra fodder in one year to sell it to the other herder. Alternatively, it will be possible for the herders to set up an insurance scheme to share the risk of an uncertain environment. However, the setup costs for a new market or a new insurance scheme would be substantial and will not be needed so long as the herders share fodder and risk by jointly sharing a larger grazing area.

It is difficult to know exactly what analysts mean when they refer to the necessity of developing private rights to some common-pool resources (CPRs). It is clear that when they refer to land, they mean to divide the land into separate parcels and assign individual rights to hold, use, and transfer these parcels as individual owners desire (subject to the general regulations of a jurisdiction regarding the use and transfer of land). In regard to nonstationary resources, such as water and fisheries, it is unclear what the establishment of private rights means. As Colin Clark has pointed out, the "tragedy of the commons" has proved particularly difficult to counteract in the case of marine fishery resources where the establishment of individual property rights is virtually out of the question" (1980, p. 117). In regard to a fugitive resource, a diversity of rights may be established giving individuals rights to use particular types of equipment, to use the resource system at a particular time and place, or to withdraw a particular quantity of resource units (if they can be found). But even when particular rights are unitized, quantified, and salable, the resource *system* is still likely to be owned in common rather than individually.¹² Again, referring to fisheries, Clark has argued that "common ownership is the fundamental fact affecting almost every regime of fishery management" (1980, p. 117).

The "only" way?

Analysts who find an empirical situation with a structure presumed to be a commons dilemma often call for the imposition of a solution by an external actor: The "only way" to solve a commons dilemma is by doing

X. Underlying such a claim is the belief that X is necessary and sufficient to solve the commons dilemma. But the content of X could hardly be more variable. One set of advocates presumes that a central authority must assume continuing responsibility to make unitary decisions for a particular resource. The other presumes that a central authority should parcel out ownership rights to the resource and then allow individuals to pursue their own self-interests within a set of well-defined property rights. Both centralization advocates and privatization advocates accept as a central tenet that institutional change must come from outside and be imposed on the individuals affected. Despite sharing a faith in the necessity and efficacy of "the state" to change institutions so as to increase efficiency, the institutional changes they recommend could hardly be further apart.

If one recommendation is correct, the other cannot be. Contradictory positions cannot both be right. I do not argue for either of these positions. Rather, I argue that both are too sweeping in their claims. Instead of there being a single solution to a single problem, I argue that many solutions exist to cope with many different problems. Instead of presuming that optimal institutional solutions can be designed easily and imposed at low cost by external authorities, I argue that "getting the institutions right" is a difficult, time-consuming, conflict-invoking process. It is a process that requires reliable information about time and place variables as well as a broad repertoire of culturally acceptable rules. New institutional arrangements do not work in the field as they do in abstract models unless the models are well specified and empirically valid and the participants in a field setting understand how to make the new rules work.

Instead of presuming that the individuals sharing a commons are inevitably caught in a trap from which they cannot escape, I argue that the capacity of individuals to extricate themselves from various types of dilemma situations *varies* from situation to situation. The cases to be discussed in this book illustrate both successful and unsuccessful efforts to escape tragic outcomes. Instead of basing policy on the presumption that the individuals involved are helpless, I wish to learn more from the experience of individuals in field settings. Why have some efforts to solve commons problems failed, while others have succeeded? What can we learn from experience that will help stimulate the development and use of a better theory of collective action – one that will identify the key variables that can enhance or detract from the capabilities of individuals to solve problems?

Institutions are rarely either private or public – "the market" or "the state." Many successful CPR institutions are rich mixtures of "private-like" and "public-like" institutions defying classification in a sterile dichotomy.

By "successful," I mean institutions that enable individuals to achieve productive outcomes in situations where temptations to free-ride and shirk are ever present. A competitive market – the epitome of private institutions – is itself a public good. Once a competitive market is provided, individuals can enter and exit freely whether or not they contribute to the cost of providing and maintaining the market. No market can exist for long without underlying public institutions to support it. In field settings, public and private institutions frequently are intermeshed and depend on one another, rather than existing in isolated worlds.

An alternative solution

To open up the discussion of institutional options for solving commons dilemmas, I want now to present a fifth game in which the herders themselves can make a binding contract to commit themselves to a cooperative strategy that they themselves will work out. To represent this arrangement within a noncooperative framework, additional moves must be overtly included in the game structure. A binding contract is interpreted within noncooperative game theory as one that is unfailingly enforced by an

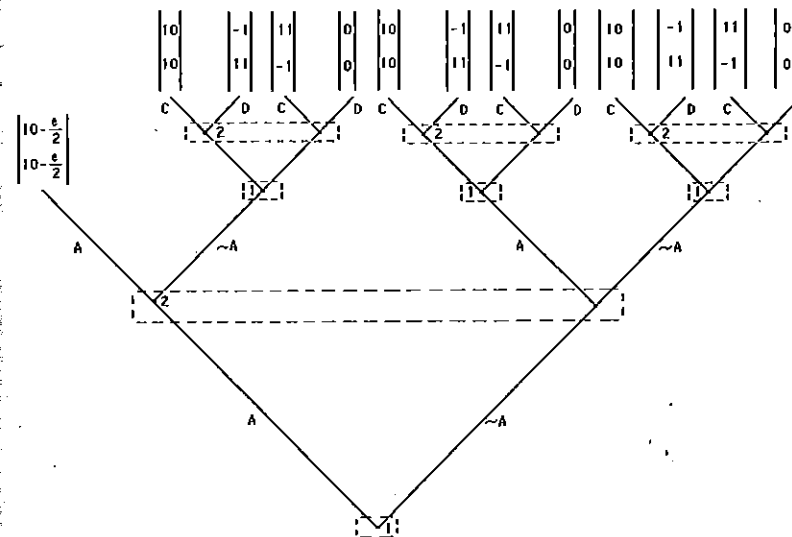


Figure 1.5. Game 5: Self-financed contract-enforcement game.

external actor – just as we interpreted the penalty posited earlier as being unfailingly enforced by the central authority.

A simple way to represent this is to add one parameter to the payoffs and a strategy to both herders' strategy sets.¹³ The parameter is the cost of enforcing an agreement and will be denoted by e . The herders in Game 5 must now negotiate prior to placing animals on the meadow. During negotiations, they discuss various strategies for sharing the carrying capacity of the meadow and the costs of enforcing their agreement. Contracts are not enforceable, however, unless agreed to unanimously by the herders. Any proposal made by one herder that did not involve an equal sharing of the carrying capacity and of enforcement costs would be vetoed by the other herder in their negotiations. Consequently, the only feasible agreement – and the equilibrium of the resulting game – is for both herders to share equally the sustainable yield levels of the meadow and the costs of enforcing their agreement so long as each herder's share of the cost of enforcement is less than 10.¹⁴

Further, in Game 5, players can *always* guarantee that the worst they will do is the (defect, defect) outcome of Game 1. They are not dependent on the accuracy of the information obtained by a distant government official regarding their strategies. If one player suggests a contract based on incomplete or biased information, the other player can indicate an unwillingness to agree. They determine their own contract and ask the enforcer to enforce only that on which they have agreed. If the enforcer should decide to charge too much for its services [any number equal to or greater than $P_i(C, C) - P_i(D, D)$, $i = 1, 2$], neither player would agree to such a contract.

The "solution" of a commons-dilemma game through instrumentalities similar to Game 5 is not presented as the "only way" to solve a commons dilemma. It is merely one way. But this way has been almost totally ignored in both the policy-analysis literature and the formal-theory literature. Contemplating such an option raises numerous questions. First, might it be possible for the herders to hire a private agent to take on the role of enforcer? This is not as farfetched as it might seem at first. Many long-term business exchanges have the structure of a prisoner's dilemma.¹⁵ Businesses are hesitant to accept promises of future performance rather than enforceable contracts, especially when beginning new business relationships. To reduce enforcement costs, however, a frequent practice is to use a private arbitrator rather than a civil court as the mechanism to achieve enforcement.¹⁶ In N-person settings, all professional athletic leagues face problems similar to those illustrated here. During the play of a professional game, the temptation to cheat and break the rules is ever present. Further,

accidents do happen, and rules get broken, even by players who were intending to follow the rules. Athletic leagues typically employ private monitors to enforce their rules.¹⁷

As soon as we allow the possibility of a private party to take on the role of an external enforcer, the nature of the "solution" offered by Game 5 to the commons dilemma begins to generate a rich set of alternative applications. A self-financed contract-enforcement game allows the participants in the situation to exercise greater control over decisions about who will be allowed to graze and what limits will be placed on the number of animals, as compared with either Game 2 or Game 3. If the parties use a private arbitrator, they do not let the arbitrator impose an agreement on them. The arbitrator simply helps the parties find methods to resolve disputes that arise within the set of working rules to which the parties themselves have agreed. Arbitrators, courts, and other arrangements for enforcement and dispute resolution make it possible for individuals to initiate long-term arrangements that they could not otherwise undertake.¹⁸ Further, as soon as one thinks about a "solution" like Game 5, it is a small step to thinking about the possibility of several arbitrators offering enforcement services at varying charges during the negotiation stage. The payoff-dominant equilibrium is to agree on that arbitrator who will enforce the contract at the lowest e .

The key difference between Game 5 and Games 2 and 3 is that the participants themselves design their own contracts in Game 5 in light of the information they have at hand. The herders, who use the same meadow year after year, have detailed and relatively accurate information about carrying capacity. They observe the behavior of other herders and have an incentive to report contractual infractions. Arbitrators may not need to hire monitors to observe the activities of the contracting parties. The self-interest of those who negotiated the contract will lead them to monitor each other and to report observed infractions so that the contract is enforced. A regulatory agency, on the other hand, always needs to hire its own monitors. The regulatory agency then faces the principal-agent problem of how to ensure that its monitors do their own job.

The proponents of the central-authority "solution" presume that such agencies have accurate information and are able to change incentives to produce something like Game 2. It is difficult for a central authority to have sufficient time-and-place information to estimate accurately both the carrying capacity of a CPR and the appropriate fines to induce cooperative behavior. I believe that situations like that in Game 3, in which incomplete information leads to sanctioning errors, occur more frequently than has been presumed in the policy literature. The need for external monitors and

enforcers is particularly acute when what is being enforced is a decision by an external agent who may impose excess costs on participants.

A further problem for consideration is that games in which enforcers have been arranged for by mutual agreement may be mistaken by analysts and public officials for games in which there have been *no* agreements about how to cooperate and enforce agreements. In other words, some examples of a "Game 5" may be mistaken for a "Game 1."¹⁹ These situations may be construed to be "informal," carrying a presumption that they are not lawful. This goes to fundamental presumptions about the nature of governments as external authorities governing over societies.

As will be seen in the later discussion of empirical cases, users of CPRs have developed a wide diversity in their own agreements, which are enforced by many mechanisms. Some of the enforcement mechanisms are external governmental agencies. Some enforcement mechanisms involve members of the users' community who have been employed as monitors and enforcers. Some enforcement mechanisms involve the users themselves as their own monitors. When the enforcement mechanism is not an external governmental agency, some analysts presume that there is no enforcement. That is why Game 5 is mistaken for Game 1.

A self-financed contract-enforcement game is no panacea. Such institutional arrangements have many weaknesses in many settings. The herders can overestimate or underestimate the carrying capacity of the meadow. Their own monitoring system may break down. The external enforcer may not be able to enforce *ex post*, after promising to do so *ex ante*. A myriad of problems can occur in natural settings, as is also the case with the idealized central-regulation or private-property institutions.

The structure of the institutional arrangements that one finds in natural settings is, of course, far more complicated than the structure of any of the extremely simple games presented here for discussion. What I attempt to do with these simple games is to generate different ways of thinking about the mechanisms that individuals may use to extricate themselves from commons dilemmas – ways different from what one finds in much of the policy literature. To challenge this mind-set, one needs only simple mechanisms that illustrate alternatives to those that normally are presented as the dominant solutions.

An empirical alternative

Game 5 illustrated a theoretical alternative to centralization or privatization as ways to solve CPR problems. Let us now briefly consider a solution devised by participants in a field setting – Alanya, Turkey – that cannot be

characterized as either central regulation or privatization. The inshore fishery at Alanya, as described by Fikret Berkes (1986b), is a relatively small operation. Many of the approximately 100 local fishers operate in two- or three-person boats using various types of nets. Half of the fishers belong to a local producers' cooperative. According to Berkes, the early 1970s were the "dark ages" for Alanya. The economic viability of the fishery was threatened by two factors: First, unrestrained use of the fishery had led to hostility and, at times, violent conflict among the users. Second, competition among fishers for the better fishing spots had increased production costs, as well as the level of uncertainty regarding the harvest potential of any particular boat.

Early in the 1970s, members of the local cooperative began experimenting with an ingenious system for allotting fishing sites to local fishers. After more than a decade of trial-and-error efforts, the rules used by the Alanya inshore fishers are as follows:

- Each September, a list of eligible fishers is prepared, consisting of all licensed fishers in Alanya, regardless of co-op membership.
- Within the area normally used by Alanya fishers, all usable fishing locations are named and listed. These sites are spaced so that the nets set in one site will not block the fish that should be available at the adjacent sites.
- These named fishing locations and their assignments are in effect from September to May.
- In September, the eligible fishers draw lots and are assigned to the named fishing locations.
- From September to January, each day each fisher moves east to the next location. After January, the fishers move west. This gives the fishers equal opportunities at the stocks that migrate from east to west between September and January and reverse their migration through the area from January to May (Berkes 1986b, pp. 73–4).

The system has the effect of spacing the fishers far enough apart on the fishing grounds that the production capabilities at each site are optimized. All fishing boats also have equal chances to fish at the best spots. Resources are not wasted searching for or fighting over a site.²⁰ No signs of overcapitalization are apparent.

The list of fishing locations is endorsed by each fisher and deposited with the mayor and local gendarme once a year at the time of the lottery. The process of monitoring and enforcing the system is, however, accomplished by the fishers themselves as a by-product of the incentive created by the

rotation system. On a day when a given fisher is assigned one of the more productive spots, that fisher will exercise that option with certainty (leaving aside last-minute breakdowns in equipment). All other fishers can expect that the assigned fisher will be at the spot bright and early. Consequently, an effort to cheat on the system by traveling to a good spot on a day when one is assigned to a poor spot has little chance of remaining undetected. Cheating on the system will be observed by the very fishers who have rights to be in the best spots and will be willing to defend their rights using physical means if necessary. Their rights will be supported by everyone else in the system. The others will want to ensure that their own rights will not be usurped on the days when they are assigned good sites. The few infractions that have occurred have been handled easily by the fishers at the local coffeehouse (Berkes 1986b, p. 74).

Although this is not a private-property system, rights to use fishing sites and duties to respect these rights are well defined. And though it is not a centralized system, national legislation that has given such cooperatives jurisdiction over "local arrangements" has been used by cooperative officials to legitimize their role in helping to devise a workable set of rules. That local officials accept the signed agreement each year also enhances legitimacy. The actual monitoring and enforcing of the rules, however, are left to the fishers.

Central-government officials could not have crafted such a set of rules without assigning a full-time staff to work (actually fish) in the area for an extended period. Fishing sites of varying economic value are commonly associated with inshore fisheries (Christy 1982; Forman 1967), but they are almost impossible to map without extensive on-site experience. Mapping this set of fishing sites, such that one boat's fishing activities would not reduce the migration of fish to other locations, would have been a daunting challenge had it not been for the extensive time-and-place information provided by the fishers and their willingness to experiment for a decade with various maps and systems. Alanya provides an example of a self-governed common-property arrangement in which the rules have been devised and modified by the participants themselves and also are monitored and enforced by them.

The case of the Alanya inshore fishery is only one empirical example of the many institutional arrangements that have been devised, modified, monitored, and sustained by the users of renewable CPRs to constrain individual behavior that would, if unconstrained, reduce joint returns to the community of users. In addition to the case studies discussed in Chapters 3, 4, and 5, productive CPR institutional arrangements have been

well documented for many farmer-managed irrigation systems, communal forests, inshore fisheries, and grazing and hunting territories.²¹

Game 5 and empirical cases of successfully governed CPRs provide theoretical and empirical alternatives to the assertion that those involved cannot extricate themselves from the problems faced when multiple individuals use a given resource. The key to my argument is that some individuals have broken out of the trap inherent in the commons dilemma, whereas others continue remorsefully trapped into destroying their own resources.²² This leads me to ask what differences exist between those who have broken the shackles of a commons dilemma and those who have not. The differences may have to do with factors *internal* to a given group. The participants may simply have no capacity to communicate with one another, no way to develop trust, and no sense that they must share a common future. Alternatively, powerful individuals who stand to gain from the current situation, while others lose, may block efforts by the less powerful to change the rules of the game. Such groups may need some form of external assistance to break out of the perverse logic of their situation.

The differences between those who have and those who have not extricated themselves from commons dilemmas may also have to do with factors *outside* the domain of those affected. Some participants do not have the autonomy to change their own institutional structures and are prevented from making constructive changes by external authorities who are indifferent to the perversities of the commons dilemma, or may even stand to gain from it. Also, there is the possibility that external changes may sweep rapidly over a group, giving them insufficient time to adjust their internal structures to avoid the suboptimal outcomes. Some groups suffer from perverse incentive systems that are themselves the results of policies pursued by central authorities. Many potential answers spring to mind regarding the question why some individuals do not achieve collective benefits for themselves, whereas others do. However, as long as analysts presume that individuals cannot change such situations themselves, they do not ask what internal or external variables can enhance or impede the efforts of communities of individuals to deal creatively and constructively with perverse problems such as the tragedy of the commons.

Policy prescriptions as metaphors

Policy analysts who would recommend a single prescription for commons problems have paid little attention to how diverse institutional arrange-

ments operate in practice. The centrists presume that unified authorities will operate in the field as they have been designed to do in the textbooks – determining the best policies to be adopted for a resource based on valid scientific theories and adequate information. Implementation of these policies without error is assumed. Monitoring and sanctioning activities are viewed as routine and nonproblematic.

Those advocating the private-property approach presume that the most efficient use patterns for CPRs will actually result from dividing the rights to access and control such resources. Systematic empirical studies have shown that private organization of firms dealing in goods such as electricity, transport, and medical services tends to be more efficient than governmental organization of such firms; for a review of this literature, see De Alessi (1980). Whether private or public forms are more efficient in industries in which certain potential beneficiaries cannot be excluded is, however, a different question. We are concerned with the types of institutions that will be most efficient for governing and managing diverse CPRs for which at least some potential beneficiaries cannot be excluded. Privatizing the ownership of CPRs need not have the same positive results as privatizing the ownership of an airline. Further, privatizing may not mean “dividing up” at all. Privatization can also mean assigning the exclusive right to harvest from a resource system to a single individual or firm.

Many policy prescriptions are themselves no more than metaphors. Both the centralizers and the privatizers frequently advocate oversimplified, idealized institutions – paradoxically, almost “institution-free” institutions. An assertion that central regulation is necessary tells us nothing about the way a central agency should be constituted, what authority it should have, how the limits on its authority should be maintained, how it will obtain information, or how its agents should be selected, motivated to do their work, and have their performances monitored and rewarded or sanctioned. An assertion that the imposition of private property rights is necessary tells us nothing about how that bundle of rights is to be defined, how the various attributes of the goods involved will be measured, who will pay for the costs of excluding nonowners from access, how conflicts over rights will be adjudicated, or how the residual interests of the right-holders in the resource system itself will be organized.

An important lesson that one learns by carefully studying the growing number of systematic studies by scholars associated with “the new institutionalism” is that these “institutional details” are important.²³ Whether or not any equilibria are possible and whether or not an equilibrium would be an improvement for the individuals involved (or for others who are in turn affected by these individuals) will depend on the particular structures

of the institutions. In the most general sense, all institutional arrangements can be thought of as games in extensive form. As such, the particular options available, the sequencing of those options, the information provided, and the relative rewards and punishments assigned to different sequences of moves can all change the pattern of outcomes achieved. Further, the particular structure of the physical environment involved also will have a major impact on the structure of the game and its results. Thus, a set of rules used in one physical environment may have vastly different consequences if used in a different physical environment.

Policies based on metaphors can be harmful

Relying on metaphors as the foundation for policy advice can lead to results substantially different from those presumed to be likely. Nationalizing the ownership of forests in Third World countries, for example, has been advocated on the grounds that local villagers cannot manage forests so as to sustain their productivity and their value in reducing soil erosion. In countries where small villages had owned and regulated their local communal forests for generations, nationalization meant expropriation. In such localities, villagers had earlier exercised considerable restraint over the rate and manner of harvesting forest products. In some of these countries, national agencies issued elaborate regulations concerning the use of forests, but were unable to employ sufficient numbers of foresters to enforce those regulations. The foresters who were employed were paid such low salaries that accepting bribes became a common means of supplementing their income. The consequence was that nationalization created *open-access resources* where limited-access *common-property resources* had previously existed. The disastrous effects of nationalizing formerly communal forests have been well documented for Thailand (Feeny 1988a), Niger (Thomson 1977; Thomson, Feeny, and Oakerson 1986), Nepal (Arnold and Campbell 1986; Messerschmidt 1986), and India (Gadgil and Iyer 1989). Similar problems occurred in regard to inshore fisheries when national agencies presumed that they had exclusive jurisdiction over all coastal waters (Cordell and McKean 1986; W. Cruz 1986; Dasgupta 1982; Panayotou 1982; Pinkerton 1989a).

A CHALLENGE

An important challenge facing policy scientists is to develop theories of human organization based on realistic assessment of human capabilities and limitations in dealing with a variety of situations that initially share

some or all aspects of a tragedy of the commons. Empirically validated theories of human organization will be essential ingredients of a policy science that can inform decisions about the likely consequences of a multitude of ways of organizing human activities. Theoretical inquiry involves a search for regularities. It involves abstraction from the complexity of a field setting, followed by the positing of theoretical variables that underlie observed complexities. Specific models of a theory involve further abstraction and simplification for the purpose of still finer analysis of the logical relationships among variables in a closed system. As a theorist, and at times a modeler, I see these efforts at the core of a policy science.

One can, however, get trapped in one's own intellectual web. When years have been spent in the development of a theory with considerable power and elegance, analysts obviously will want to apply this tool to as many situations as possible. The power of a theory is exactly proportional to the diversity of situations it can explain. All theories, however, have limits. Models of a theory are limited still further because many parameters must be fixed in a model, rather than allowed to vary. Confusing a model – such as that of a perfectly competitive market – with the theory of which it is one representation can limit applicability still further.

Scientific knowledge is as much an understanding of the diversity of situations for which a theory or its models are relevant as an understanding of its limits. The conviction that all physical structures could be described in terms of a set of perfect forms – circles, squares, and triangles – limited the development of astronomy until Johannes Kepler broke the bonds of classical thought and discovered that the orbit of Mars was elliptical – a finding that Kepler himself initially considered to be no more than a pile of dung (Koestler 1959). Godwin and Shepard (1979) pointed out a decade ago that policy scientists were doing the equivalent of “Forcing Squares, Triangles and Ellipses into a Circular Paradigm” by using the commons-dilemma model without serious attention to whether or not the variables in the empirical world conformed to the theoretical model. Many theoretical and empirical findings have been reported since Godwin and Shepard's article that should have made policy scientists even more skeptical about relying on a limited set of models to analyze the diversity of situations broadly referred to as CPR problems. Unfortunately, many analysts – in academia, special-interest groups, governments, and the press – still presume that common-pool problems are all dilemmas in which the participants themselves cannot avoid producing suboptimal results, and in some cases disastrous results.

What is missing from the policy analyst's tool kit – and from the set of accepted, well-developed theories of human organization – is an ade-

quately specified theory of collective action whereby a group of principals can organize themselves voluntarily to retain the residuals of their own efforts. Examples of self-organized enterprises abound. Most law firms are obvious examples: A group of lawyers will pool their assets to purchase a library and pay for joint secretarial and research assistance. They will develop their own internal governance mechanisms and formulas for allocating costs and benefits to the partners. Most cooperatives are also examples. The cases of self-organized and self-governed CPRs that we consider in Chapter 3 are also examples. But until a theoretical explanation – based on human choice – for self-organized and self-governed enterprises is fully developed and accepted, major policy decisions will continue to be undertaken with a presumption that individuals cannot organize themselves and always need to be organized by external authorities.

Further, all organizational arrangements are subject to stress, weakness, and failure. Without an adequate theory of self-organized collective action, one cannot predict or explain when individuals will be unable to solve a common problem through self-organization alone, nor can one begin to ascertain which of many intervention strategies might be effective in helping to solve particular problems. As discussed earlier, there is a considerable difference between the presumption that a regulatory agency should be established and the presumption that a reliable court system is needed to monitor and enforce self-negotiated contracts. If the theories being used in a policy science do not include the possibility of self-organized collective action, then the importance of a court system that can be used by self-organizing groups to monitor and enforce contracts will not be recognized.²⁴

I hope this inquiry will contribute to the development of an empirically supported theory of self-organizing and self-governing forms of collective action. What I attempt to do in this volume is to combine the strategy used by many scholars associated with the “new institutionalism” with the strategy used by biologists for conducting empirical work related to the development of a better theoretical understanding of the biological world.

As an institutionalist studying empirical phenomena, I presume that individuals try to solve problems as effectively as they can. That assumption imposes a discipline on me. Instead of presuming that some individuals are incompetent, evil, or irrational, and others are omniscient, I presume that individuals have very similar limited capabilities to reason and figure out the structure of complex environments. It is my responsibility as a scientist to ascertain what problems individuals are trying to solve and what factors help or hinder them in these efforts. When the problems that I observe involve lack of predictability, information, and trust, as well as high levels

of complexity and transactional difficulties, then my efforts to explain must take these problems overtly into account rather than assuming them away. In developing an explanation for observed behavior, I draw on a rich literature written by other scholars interested in institutions and their effects on individual incentives and behaviors in field settings.

Biologists also face the problem of studying complex processes that are poorly understood. Their scientific strategy frequently has involved identifying for empirical observation the simplest possible organism in which a process occurs in a clarified, or even exaggerated, form. The organism is not chosen because it is representative of all organisms. Rather, the organism is chosen because particular processes can be studied more effectively using this organism than using another.

My "organism" is a type of human situation. I call this situation a CPR situation and define exactly what I mean by this and other key terms in Chapter 2. In this volume, I do not include all potential CPR situations within the frame of reference. I focus entirely on small-scale CPRs, where the CPR is itself located within one country and the number of individuals affected varies from 50 to 15,000 persons who are heavily dependent on the CPR for economic returns. These CPRs are primarily inshore fisheries, smaller grazing areas, groundwater basins, irrigation systems, and communal forests. Because these are relatively small-scale situations, serious study is more likely to penetrate the surface complexity to identify underlying similarities and processes. Because the individuals involved gain a major part of their economic return from the CPRs, they are strongly motivated to try to solve common problems to enhance their own productivity over time. The effort to self-organize in these situations may be somewhat exaggerated, but that is exactly why I want to study this process in these settings. Further, when self-organization fails, I know that it is not because the collective benefits that could have been obtained were unimportant to the participants.

There are limits on the types of CPRs studied here: (1) renewable rather than nonrenewable resources, (2) situations where substantial scarcity exists, rather than abundance, and (3) situations in which the users can substantially harm one another, but not situations in which participants can produce major external harm for others. Thus, all asymmetrical pollution problems are excluded, as is any situation in which a group can form a cartel and control a sufficient part of the market to affect market price.

In the empirical studies, I present a synopsis of important CPR cases that have aided my understanding of the processes of self-organization and self-governance. These cases are in no sense a "random" sample of cases. Rather, these are cases that provide clear information about the processes

involved in (1) governing long-enduring CPRs, (2) transforming existing institutional arrangements, and (3) failing to overcome continued CPR problems. These cases can thus be viewed as a collection of the most salient raw materials with which I have worked in my effort to understand how individuals organize and govern themselves to obtain collective benefits in situations where the temptations to free-ride and to break commitments are substantial.

From an examination and analysis of these cases, I attempt to develop a series of reasoned conjectures about how it is possible that some individuals organize themselves to govern and manage CPRs and others do not. I try to identify the underlying design principles of the institutions used by those who have successfully managed their own CPRs over extended periods of time and why these may affect the incentives for participants to continue investing time and effort in the governance and management of their own CPRs. I compare the institutions used in successful and unsuccessful cases, and I try to identify the internal and external factors that can impede or enhance the capabilities of individuals to use and govern CPRs.

I hope these conjectures contribute to the development of an empirically valid theory of self-organization and self-governance for at least one well-defined universe of problematical situations. That universe contains a substantial proportion of renewable resources heavily utilized by human beings in different parts of the world. It is estimated, for example, that 90% of the world's fishermen and over half of the fish consumed each year are captured in the small-scale, inshore fisheries included within the frame of this study (Panayoutou 1982, p. 49). Further, my choice of the CPR environment for intensive study was based on a presumption that I could learn about the processes of self-organization and self-governance of relevance to a somewhat broader set of environments.

Given the similarity between many CPR problems and the problems of providing small-scale collective goods, the findings from this volume should contribute to an understanding of the factors that can enhance or detract from the capabilities of individuals to organize collective action related to providing local public goods. All efforts to organize collective action, whether by an external ruler, an entrepreneur, or a set of principals who wish to gain collective benefits, must address a common set of problems. These have to do with coping with free-riding, solving commitment problems, arranging for the supply of new institutions, and monitoring individual compliance with sets of rules. A study that focuses on how individuals avoid free-riding, achieve high levels of commitment, arrange for new institutions, and monitor conformity to a set of rules in CPR environments should contribute to an understanding of how in-

dividuals address these crucial problems in some other settings as well.

Let me now give a brief sketch of how this book is organized. In Chapter 2, I define what I mean by a CPR situation and individual choice in a CPR situation. Then I examine a series of crucial questions that any theory of collective action must answer. To conclude the chapter, I examine two assumptions that have framed prior work and discuss the alternatives that frame my analysis. The empirical part of this volume is contained in Chapters 3, 4, and 5, where I examine specific cases of long-enduring CPR institutions and resources, the origin and development of CPR institutions, and CPR failures and fragilities. At the end of each empirical chapter, I consider what can be learned from the cases in that chapter that will contribute toward the development of a better theory of self-organization related to CPR environments. In Chapter 6, I pull together the theoretical reflections contained at the ends of Chapters 3, 4, and 5 and address the implications of these conjectures for the design of self-organizing and self-governing institutions.

2

An institutional approach to the study of self-organization and self-governance in CPR situations

In Chapter 1, I described my strategy as that of a "new institutionalist" who has picked small-scale CPR situations to study because the processes of self-organization and self-governance are easier to observe in this type of situation than in many others. The central question in this study is how a group of principals who are in an interdependent situation can organize and govern themselves to obtain continuing joint benefits when all face temptations to free-ride, shirk, or otherwise act opportunistically. Parallel questions have to do with the combinations of variables that will (1) increase the initial likelihood of self-organization, (2) enhance the capabilities of individuals to continue self-organized efforts over time, or (3) exceed the capacity of self-organization to solve CPR problems without external assistance of some form.

This chapter has several objectives. First, I define what I mean by CPRs and how I view individual behaviors in complex and uncertain CPR situations. Then I examine the general problem facing individuals in CPR situations: how to organize to avoid the adverse outcomes of independent action. This general problem is solved by external agents in two well-accepted theories: the theory of the firm and the theory of the state. These explain how new institutions are supplied, how commitments are obtained, and how the actions of agents and subjects are monitored effectively, using in one case the firm, and in the other state, as an organizational device. How a group of principals – a community of citizens – can organize themselves to solve the problems of institutional supply, commitment, and monitoring is still a theoretical puzzle. Given that some individuals solve this puzzle, whereas others do not, a study of successful and unsuccessful efforts to solve CPR problems should address important issues related to the theory of collective action and the development of better policies related to CPRs. Many efforts to analyze collective-action problems have

4

Analyzing institutional change

In the preceding chapter I examined institutions for governing CPRs in which appropriators have devised governance systems that have survived for long periods of time in environments characterized by considerable uncertainty and change. Although the particular problems involved in governing mountain commons vary from those involved in governing irrigation systems, all of these long-enduring institutional arrangements have shared commonalities. These cases clearly demonstrate the feasibility (but obviously not the likelihood) of robust, self-governing institutions for managing complex CPR situations, but the origins of these systems are lost in time. It is not possible to reconstruct how earlier users of Swiss alpine meadows, Japanese mountain commons, the Spanish *huertas*, or the Philippine *zanjeras* devised rules that have survived such long periods. We do not know who originated or opposed various proposals, or anything about the process of change itself.

A study of the origins of institutions must address the problem of supply raised in Chapter 2. As Bates (1988) points out, the presence of collective benefits as a result of designing new institutions is itself a second-order collective dilemma. A proposed new institution "is subject to the very incentive problems it is supposed to resolve" (Bates 1988, p. 395). Many questions need to be addressed. How many participants were involved? What was their internal group structure? Who initiated action? Who paid the costs of entrepreneurial activities? What kind of information did participants have about their situation? What were the risks and exposures of various participants? What broader institutions did participants use in establishing new rules? These questions are rarely answered in the extensive case-study literature describing behavior within ongoing institutional arrangements. Once a set of rules is in place, the incentives facing

appropriators are entirely different from the incentives that faced an earlier set of appropriators when confronted with severe appropriation or provision suboptimality.

In this chapter, the origins of a set of institutions to manage a series of groundwater basins located beneath the Los Angeles metropolitan area are examined. Louis Weschler and I did extensive fieldwork in these areas during the late 1950s and early 1960s, when many changes were occurring (E. Ostrom 1965; Weschler 1968). We attended meetings, read internal memoranda, and interviewed participants to obtain information about the strategies of groundwater producers to organize voluntary associations, to undertake litigation, to create special districts, and to constitute a complex public-private governance system to regulate their basins. Recently, William Blomquist (1987a, 1988a-e) has expanded the number of groundwater basins studied and updated the available information. For these groundwater basins, we have a good understanding of the processes involved in changing the rules, and sufficient time has elapsed to allow us to evaluate the stability and efficiency of the results obtained in using these rules to govern and manage these basins. In this chapter we examine the processes of changing the rules in three basins (Raymond, West, and Central) that have relied on negotiated settlements of water rights as a key element in the transformation of their situation.¹ See Figure 4.1 for a map of the area.

THE COMPETITIVE PUMPING RACE

The setting

In an earlier geologic era, rivers and streams draining the mountains surrounding what has now become the Los Angeles metropolitan area laid down wide and deep bands of sand and gravel that were then partially overlaid by hard layers of clay. The former streambeds are now deep, water-bearing strata that can be thought of as underground reservoirs. These reservoirs are replenished by the rains that fall in the foothills and upper valleys and, to a more limited extent, by precipitation and drainage on the flat coastal plain itself.

In a semiarid region such as Los Angeles, groundwater basins are extremely valuable when used in conjunction with surface supply systems. First, they are sources of inexpensive and high-quality water, as compared with the cost of importing water from long distances. In 1985, the Metropolitan Water District charged \$240 per acre-foot (the volume of water that would cover one acre of land with one foot of water) as the wholesale price for imported water from northern California and from the Colorado

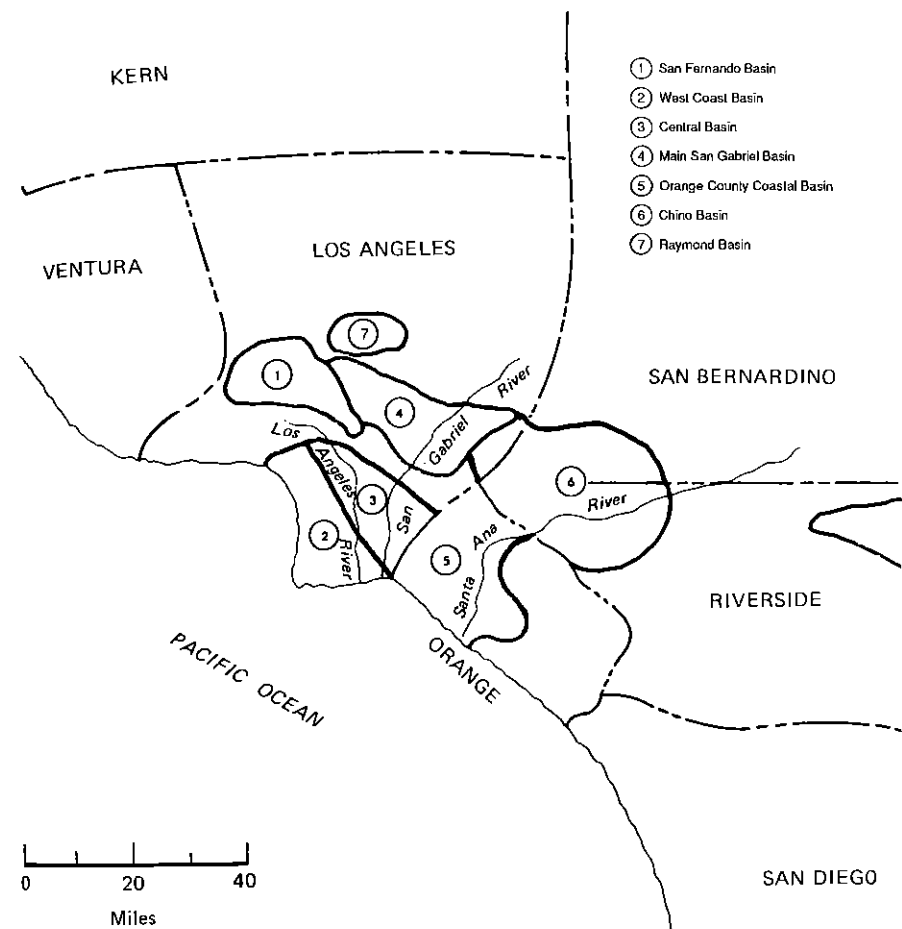


Figure 4.1. Groundwater basins underlying the south coastal plain in California. (Adapted from Lipson 1978.)

River. The cost of pumping groundwater in the Los Angeles area averaged around \$134 per acre-foot – a saving of more than \$100 per acre-foot. If the 282,458 acre-feet of groundwater that were pumped in 1985 from the three basins discussed in this chapter had been replaced with surface water, it would have cost the industrial users, the urban households, and the irrigators at least \$28 million more per year.²

The value of the basins as sources of water supply is overshadowed, however, by their even greater value as natural storage vessels that can retain water for use during periods of peak demand.³ Every surface-water system must have available some type of short-term storage so that it can rapidly meet the accelerated demands of water users that occur at regular intervals during each day and each week, and during the course of a year. The current construction costs for a water tower in the Los Angeles area average around \$57,500 per acre-foot (Blomquist 1987a). The minimum amount of short-term storage recommended by the relevant engineering standards is 16% of the total water used in an area. In the area of the West Basin, with an annual demand for water of 327,435 acre-feet, storage reservoirs that could hold 52,400 acre-feet would be required if the basin were not available for this purpose. The replacement costs for this single basin would be about \$3.01 billion. The loss of all the groundwater basins underlying the Los Angeles metropolitan area would be an economic disaster of major proportions.

Groundwater basins can be destroyed by overextraction and/or pollution. If more water is withdrawn per year than the average level of replenishment (referred to as the safe yield of a basin), eventually the gravel and sand in the water-bearing strata will compact so that they cannot hold as much water as they formerly did. If a groundwater basin is located near the ocean, and its water level is drawn down below sea level, saltwater intrusion will occur along the coast. Wells along the coastline must be abandoned. If intrusion is not halted, eventually the entire basin will no longer be usable as a source of supply or for its storage capacity. Over-extraction threatened all of the groundwater basins in this region until institutional changes were initiated by those affected.

The logic of the water-rights game

Overextraction was the logical outcome of the way groundwater rights were defined prior to the institutional changes described in this chapter. Water rights in California had been defined on the basis of whether a producer owned the overlying land and used the water on that land (an overlying landowner) or used the water to serve areas other than land

owned by the water producer (an appropriator). Under the common law, an overlying landowner held a riparian right to the “full flow” of the water supply underlying his or her land (Nunn 1985). In a region of extreme scarcity of water, the common law does not provide secure rights for an overlying landowner. Water underlying any parcel of land (e.g., parcel A) can be siphoned to a neighbor’s land if the neighbor withdraws water more rapidly than does the owner of parcel A. In *Katz v. Walkinshaw* [141 Cal. 116, 74 P. 766 (1903)], the doctrine of “correlative rights” was developed to replace the strict interpretation of riparian rights. That doctrine held that in times of shortage, if the court was called on to adjudicate among competing interests, the court would treat all overlying owners as correlative and coequal owners. In times of scarcity, each would gain a *proportionate* share of the water rather than an *absolute* share of the water. That doctrine was modified somewhat in *San Bernardino v. Riverside* [186 Cal. 7 (1921)], in which overlying landowners were limited to taking only water that they could put to “beneficial” use.

Thus, overlying landowners facing only other overlying landowners knew that if they went to court to settle a dispute over water rights during a time of shortage, they would all share proportionately in any cutback in the total water available to them. In most groundwater basins, however, overlying landowners faced other water users called “appropriators,” whose claim to water was on a different basis than that of an overlying landowner. Appropriators pumped groundwater to be used on land not owned by those withdrawing the water. Most private and public water companies were legally classified as appropriators, because the water they pumped was used by their customers, not by the water companies themselves. Nonoverlying landowners were allowed, if not encouraged, by the appropriative-rights doctrines made part of the statutory law in 1872 to withdraw “surplus water” or water that was not being put to beneficial use by the overlying landowners. The key elements in defining the rights of an appropriator had to do with

- 1 when the appropriator began to withdraw water from the source,
- 2 how much water was actually put to beneficial use, and
- 3 whether or not the use was continuous.

Under the doctrine of “first in time, first in right,” appropriators acquired rights depending on their history of use. Among appropriators, a court-resolved conflict over a scarce supply would exclude use by the most junior appropriator, and then the next most junior appropriator, and so forth. The most senior appropriators would be fully protected against encroachment on their rights by more junior appropriators. However, the rights of

the most senior appropriators were potentially subordinate to those of overlying landowners.

The simultaneous existence of the doctrines of correlative and appropriative rights in the same state introduced considerable uncertainty about the relative rights of one groundwater producer against others. The uncertainty was compounded by the presence of a third common-law doctrine that enabled groundwater producers to gain rights through "adverse use" or prescription. In regard to land, prescriptive rights are relatively straightforward: If one person occupied someone else's land in an open, notorious, and continuous manner for a set period of time (five years in California), and the owner makes no effort to eject the occupier, the original owner loses the right to the land.

In regard to groundwater, possession of water was not enough to establish open and *adverse* use. Any junior appropriator could legally use any water that was surplus water. Surplus water was defined as a part of the "safe yield" of a basin that was not of beneficial use to overlying landowners or senior appropriators. The safe yield of a basin is the average, long-term supply of water to the basin. If that quantity of water was put to beneficial use, no surplus was available to others. An appropriator had to take nonsurplus water openly and continuously for more than five years to perfect prescriptive rights. Once perfected, prescriptive rights were superior to those of overlying owners and appropriators. The same actions of an appropriator – openly taking water continuously from a basin – could lead to the acquisition of rights *superior* to those of overlying landowners or, alternatively, to the *inferior* rights of a junior appropriator relative to an overlying landowner in time of scarcity. The key difference between these outcomes was whether the court ruled that a surplus did or did not exist for the five-year period prior to litigation. Given that all producers suffered from lack of information concerning the safe yield of a basin and the pumping rates of other producers, no one knew at the time of making such decisions what the pumping rates were or whether or not a surplus existed.

The situation in these basins can be characterized as an open-access CPR for which clear limits have not been established regarding who can withdraw how much water. In such situations, two strong pressures encourage pumpers to adopt inefficient strategies. The first is a pumping-cost externality. The second is a strategic externality (Negri 1989). Pumping costs increase as the pumping lift increases, because of falling water levels, and therefore each person's withdrawals increase the pumping costs for others. No one bears the full cost of personal actions. Each pumper is consequently

led toward overexploitation. The strategic externality involved in an open-access groundwater basin is aptly described by Negri (1989, p. 9).

With property rights undefined and access nonexclusive, the "rule of capture" governs the "ownership" of the reserve stock. The rule of capture grants [pumpers] exclusive rights to that portion of the groundwater that they pump. What an operator does not withdraw today will be withdrawn, at least in part, by rival[s]. The fear that [pumpers] cannot capture tomorrow what they do not pump today undermines their incentive to forgo current pumping for future pumping.

The two incentives reinforce one another to aggravate the intensity of the pumping race. Without a change of institutions, pumpers in such a situation acting independently will severely overexploit the resource. Overexploitation can lead to destruction of the resource itself.

Current institutions affect not only the intensity of a pumping race but also the relative incentives of different participants to initiate institutional change. Given the legal structure of rights in California, overlying landowners were more motivated than appropriators to launch court action so as to keep appropriators from obtaining prescriptive rights. The decision about when to start litigation, however, involved high risks of being too soon or too late. The overlying owner faced two possibilities:

- (1) If he went to court before all "surplus" water had been appropriated, and the court ruled that the water being diverted by the defendant was indeed surplus water, the overlying owner would suffer the costs of the litigation and receive no remedy;
- (2) If he waited too long to go to court, the overlying owner might find that the defendant had perfected a prescriptive right if the court ruled that the water being diverted was non-surplus water. There was, in other words, no way for the overlying owner, on whom the burden of initiating litigation rested, to succeed in protecting his right until it had been invaded, and yet within a short time after the right had been invaded, the overlying owner would have lost the right he sought to protect due to prescription.

(Blomquist 1988a, p. 19)

The uncertainty of the competing water doctrines was compounded by the uncertainty shared by all water producers about the actual supply of water to a basin and the quantity of water withdrawn by all of the parties. It was essential to know the quantities supplied and demanded from a basin to determine the presence or absence of a surplus. Both types of information were costly to obtain. Both could be obtained at the time of litigation

by asking the court to appoint a watermaster to make a geologic survey of the basin and determine its water supply and to obtain information about the past water uses of all producers. When determined in this manner, the cost would be shared by all producers involved in the litigation. But that did not solve the problem of uncertainty prior to the initiation of litigation. In past cases, signs of potential problems – such as falling water tables – had not been accepted by the court as sufficient evidence of a water shortage to declare a lack of surplus and uphold the rights of overlying owners as against junior appropriators [*San Bernardino v. Riverside*, 186 Cal. 7 (1921)].

Given these compound uncertainties, it is easy to explain the behavior of groundwater pumpers in the Los Angeles metropolitan area during the first 50 years of this century. To obtain any kind of water right, one needed to show continuous withdrawal of water and application to beneficial use. In that environment of legal uncertainty, attorneys advised producers to pump as much as they needed and to defend later (Krieger 1955). A pumping race occurred in each of the groundwater basins underlying the Los Angeles area.

Given those incentives, many water producers and local government officials during the 1940s and 1950s worried that all of the basins would be severely overdrawn and that those basins located adjacent to the ocean – West Basin and Central Basin – would be lost to the sea. By the 1960s, however, the pumping race had been halted in all of the coastal basins. Water rights were eventually established in all the basins, except in Orange County, which continues to rely on a pump tax for regulation.⁴

Special water districts have been established throughout the area to obtain surface water, to levy pump taxes on water production, and to replenish the basins through a variety of artificial means. A series of injection wells has been constructed along the coast to create a barrier of fresh water against the sea, enabling the coastal districts to regulate the uses of their basins in a manner similar to the use of a surface reservoir. In other words, diverse private and public actors have extricated themselves from the perversity of the pumping race and transformed the entire structure of the incentives they face. Public arenas were involved in many stages of these developments. The initial steps were taken in the shadow of a court order. Elections and public hearings were held at key stages. The solutions to the pumping race, however were not imposed on the participants by external authorities. Rather, the participants used public arenas to *impose constraints on themselves*. Because litigation to gain defined water rights was involved in all of the basins, except in Orange County, we first discuss this strategy to transform the pumping race.

THE LITIGATION GAME

*The Raymond Basin negotiations*⁵

The Raymond Basin is a small basin, with a surface area of 40 square miles, located inland and thus protected from saltwater intrusion. The area was already highly developed by the turn of the century. Later studies have revealed that the safe yield of the basin was steadily exceeded from 1913 onward. The cities of Pasadena, Sierra Madre, Arcadia, Altadena, La Cañada-Flintridge, South Pasadena, San Marino, and Monrovia are located on the surface of the basin. The city of Alhambra lies on its borders and appropriates water from the basin for use within its boundaries. The city of Pasadena was by far the largest producer of water from the basin – its production equaled the production of the other 30 producers combined. Pasadena thus approached, but did not reach, the position of a dominant actor in a privileged group (Olson 1965). According to Olson's model, if the Raymond Basin producers had been a privileged group, the city of Pasadena would have borne all of the costs associated with stopping the pumping race. The prediction one derives from Olson's model is consistent with some, but not all, of the activities pursued by the city of Pasadena.

The city of Pasadena for some years adopted the strategy of the dominant player in a privileged group. From 1914 to 1923, for example, the city replenished the basin by capturing floodwaters and spreading them on the gravel areas located at the feet of the San Gabriel Mountains. The water that percolated into the basin was then available for capture by the city of Pasadena as well as by other groundwater producers. In the late 1920s, the city of Pasadena was a leading participant in the formation of the Metropolitan Water District of Southern California, which would eventually construct an aqueduct to bring water 250 miles to the Los Angeles area from the Colorado River.

During the 1930s, however, the city of Pasadena was no longer willing to undertake independent actions that were substantially benefiting others who were not contributing to the costs. The city tried unsuccessfully to negotiate a voluntary settlement with the other producers whereby all producers would jointly reduce the amounts of water they were withdrawing from the basin. In 1937 Pasadena initiated legal proceedings against the city of Alhambra and 30 other producers.⁶ The case was referred to the Division of Water Resources of the California Department of Public Works for determination of the geologic structure of the basin, the safe yield of the basin, and whether or not there was a surplus.

That referral procedure was time-consuming and costly. The draft report of the referee was not completed until March of 1943 and cost about

\$53,000. The referee found that the yearly withdrawals from the basin were 29,400 acre-feet, whereas the safe yield of the basin was 21,900, leading to an annual overdraft of 8,500 acre-feet per year. The referee recommended that the parties curtail their pumping to the safe yield of the basin.

The parties then shared a single, authoritative "image" of the problem they faced. They also would confront a new "default condition" (E. Ostrom 1986a) if they could not agree on their own solution. Prior to litigation, the failure to agree would simply mean a return to the pumping race. Once the court took jurisdiction, an absence of agreement would mean that the judge would decide which parties had to bear the brunt of the cutback. It was not at all clear what the judge would decide. The judge might, for example, assign preeminent rights to the overlying owners and then assign the remainder of the 21,900 acre-feet as a "surplus" to the appropriators to be apportioned according to their seniority. Or the judge might decide that there was no surplus. In that case, senior appropriators might be granted prescriptive rights, and overlying landowners would bear the major brunt of the cutback.

A simplified picture of the bargaining problem that the producers faced is shown in Figure 4.2. If we assume that the overlying owners were withdrawing 12,000 acre-feet and the appropriators (who might become prescriptors) were withdrawing 18,000 acre-feet, the total withdrawals prior to a decision would be 30,000 acre-feet. Everyone accepted the fact that a cutback to 22,000 acre-feet would occur. A worst-case analysis done by the overlying landowners would assume that the judge would declare that there had been no surplus for more than five years prior to litigation. Thus, the appropriators would be given superior rights to all that they had withdrawn. They would be assigned 18,000 acre-feet, leaving only 4,000 acre-feet for the overlying landowners. Point B marks the worst possible solution that the overlying owners could face.

Similarly, the appropriators could do a worst-case analysis and assume that the judge would assign firm rights of 12,000 acre-feet to the overlying landowners and then assign the "surplus" of 10,000 acre-feet to the appropriators according to their seniority. Point A is the worst possible solution from the perspective of the appropriators. For all participants, the range of variation between complete protection and major loss (the line connecting A and B) would be considerable. Further, a fully contested trial would last a long time, given the conflicting legal doctrines, and the costs of litigation would be extremely high.

At the instigation of the city of Pasadena, the parties held some serious negotiations in the shadow of the court. Within six months they had

drafted a stipulated agreement signed by all but 2 of the 32 parties involved in the litigation. The negotiation process was furthered in that instance by the unusual fact that one attorney, Kenneth Wright, represented 16 of the parties. After another six months, one of the holdouts also agreed to the stipulation. The other – the California-Michigan Land and Water Company – never agreed to the stipulation and challenged the final court decision based on the stipulation.

The signatories agreed that the safe yield had been exceeded for a long time and that it was necessary to cut back to the safe yield of the basin. They stated that each producer's withdrawal of groundwater had been open, continuous, and notorious and was, because of the overdraft, adverse to the claims of all of the others. Thus, each producer had prescribed against all of the others. The term "mutual prescription" has been used to describe the concept used by these parties as the foundation for their negotiated settlement. The signatory parties agreed to *share the cutback proportionately* instead of pursuing further legal procedures to determine whose rights took precedence.⁷ The proportional division of the cutback is represented by point D in Figure 4.2.⁸ They further guaranteed each other's proportional shares of the safe yield (if it were to change in the future) and established an arrangement to enable those most adversely affected by the

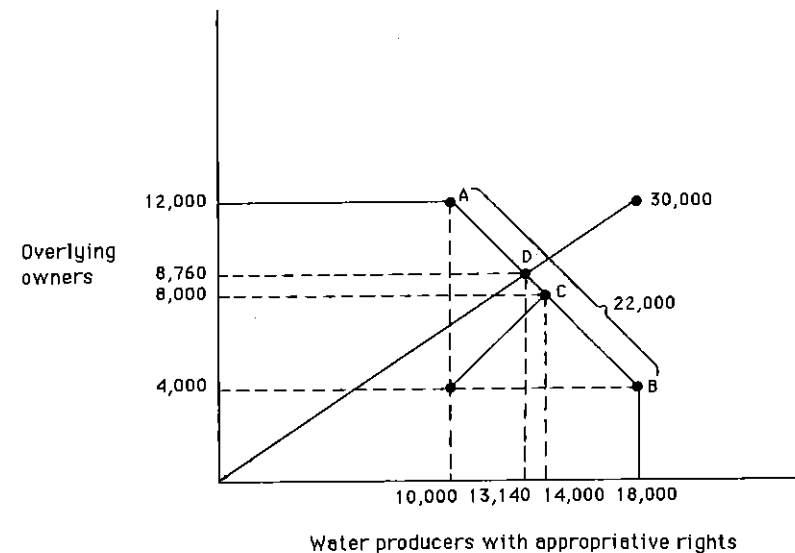


Figure 4.2. The bargaining situation faced by overlying owners and appropriators.

cutback to obtain exchange rights from others willing to sell their rights on an annual basis.

A short trial was held to hear the objections of the California-Michigan Land and Water Company and to assign the Division of Water Resources of the California Department of Public Works to serve as the watermaster—an official monitor—to supervise the agreement. Rather than imposing his own solution,⁹ the judge, after considerable reflection, issued a final judgment on December 23, 1944,¹⁰ based on the stipulated agreement. The final judgment declared all of the decreed rights to be of equal standing in any future dispute and enjoined all parties from taking more than their decreed rights. The judgment continued the role of the watermaster to enforce the provisions of the judgment and to supervise the exchange pool they had developed. In addition to the leasing arrangements of the exchange pool, decreed rights could be leased or sold outright so long as the transfers were recorded by the watermaster. Two-third of the costs of the watermaster were to be paid for by the parties, and the state of California would pay for the remaining costs of monitoring the agreement. The case was appealed to the California Supreme Court, and the decision was upheld.¹¹ The United States Supreme Court declined to review the case.

By negotiating their own agreement, the parties had ended the pumping race faster and at a lower cost than they could have through a court proceeding.¹² They also had gained firm and marketable rights to defined shares of the safe yield of the basin. A market for those water rights developed, and most of the smaller right-holders have sold their rights to the water companies, for whom the rights have a higher value. There are now 17 active producers from the basin, and they are almost all municipal or private water companies. Only three overlying landowners continue to produce water from the basin. The areas within the basin that did not have access to imported water formed a municipal water corporation in 1953 and started receiving imported water in 1955.

The West Basin negotiations

West Basin, with a surface area of 170 square miles, is a much larger area than Raymond Basin. Located immediately adjacent to the ocean, it extends from the city of Inglewood to the Palos Verdes Peninsula. The situation in West Basin was not as favorable for negotiations as that facing the Raymond Basin producers. The major advantage for the West Basin producers was that their upland neighbors had already borne the costs of innovation and had developed a formula for reaching a negotiated settlement within the California legal environment that was considered to be fair

by many potential litigants. The disadvantages faced in West Basin included (1) a large number of producers (around 500 parties were named in the litigation), (2) the absence of a single dominant producer, and (3) considerable asymmetry in the risks regarding saltwater intrusion (those near the sea would lose their wells long before those pumping inland). The problem of the size of the group was offset to some extent by the concentrated nature of the groundwater production in the basin: 19 producers accounted for about 85% of the total quantity of water withdrawn from West Basin.¹³

The overdraft came a decade later to West Basin than to Raymond Basin. The heavy industrialization that occurred during World War II exacerbated the already growing overdraft, particularly because there were many oil companies located in the area whose water production had increased steadily. In the early 1940s, wells located along the coast began to show increasing salinity. Many water producers in the basin continued to believe, however, that the salinity in those wells was symptomatic of only a "local" problem immediately along the coast, not a more general problem that could affect their own situation in the future. During 1943, nine of the coastal municipalities met several times to discuss the importance of the increasing salinity of their wells. They agreed that more information was needed to gain a realistic and common image of the structure of the groundwater basin. Those cities signed a cooperative agreement with the United States Geological Survey and the Los Angeles County Flood Control District to undertake an initial study of the problem of groundwater supply in the basin.¹⁴

The report, completed in 1944, painted a grim picture. Wells all along the coast had been invaded by seawater. The investigators had found no natural barrier at any point in the basin to halt the advance of the sea. The entire basin was threatened with destruction. The report provided a common image of the general boundaries of the basin and the extent of the problem without providing an exact picture of the safe yield and current levels of water production. It was no longer possible, however, for producers to maintain that the salinity in the coastal wells was strictly a local problem.

In December of 1944, all of the major water producers met and established an ad hoc committee to consider what should be done next. That committee had three major recommendations:

- 1 that a permanent association be created of all interested water producers so that they could continue to discuss their mutual problems and possible joint actions,

- 2 that a technical survey be made of alternative sources of water for the area, and
- 3 that water producers consider initiating legal action similar to the action just completed in Raymond Basin to reduce total pumping and to ration the limited water supply in West Basin among all water producers (Ways and Means Committee 1945, p. 16).

All three recommendations were followed. The West Basin Water Association was created within a few months.¹⁵ The association provided a continuous open forum¹⁶ for discussion of all major steps taken in West Basin by producers and representatives of various local, regional, and state public agencies. The resources of the association frequently were used to obtain and make available the best possible technical information about the basin. Extensive minutes were kept for all West Basin Water Association meetings, as well as the meetings of the Executive Committee and most of the working committees of the association. Those files were open to all members, as well as to others interested in gaining information about past decisions, technical data, and studies of the benefits and costs of alternatives. A weekly newsletter was dispatched to all members from 1946 through 1954. The motto of the newsletter, according to its editor, was "let there be no surprises, either pleasant or unpleasant" (Fossette and Fossette 1986, p. 57). The practice of obtaining the best information available and disseminating it widely increased the degree of understanding and level of cooperation among the participants.

The first official act of the association, in March 1946, was to retain a renowned engineer, Harold Conkling, to examine the possibility of finding alternative sources of supplemental water for the basin. Conkling recommended the creation of a municipal water district to import water from the Metropolitan Water District of Southern California. Obtaining surface water eventually would mean that the groundwater basin would no longer serve as the major source of water for the area, but the question who would obtain rights to use the reservoir capacities of the basin had to be resolved.

Three appropriators initiated the West Basin litigation in October 1945: the California Water Service Company, the city of Torrance, and the Palos Verdes Water Company. Kenneth Wright, who had served as the attorney for the city of Pasadena in the Raymond Basin litigation, was the attorney for the California Water Service Company and had made several presentations to West Basin producers concerning the mutual-prescription concept used in the Raymond Basin case. Although the initiators of the litigation, and many other water producers in the basin, strongly supported the

concept of proportionate cutbacks by all water producers, several major water producers vigorously opposed such a plan.

The Dominguez Water Corporation, a senior appropriator with overlying rights as well, was one strong opponent. Because Dominguez was the largest producer from the basin,¹⁷ it was unlikely that others would agree to a curtailment without the participation of the Dominguez Corporation. The city of Inglewood initially opposed the litigation and all of the actions proposed within the context of the West Basin Water Association. Inglewood's lawyers had advised city officials that its status as senior appropriator would protect it from having to cut back production. Inglewood's position changed, however, after the Raymond Basin decision had been sustained in the California Supreme Court.¹⁸ Inglewood, which owned some wells near the sea, was to become an active participant in the effort to find solutions.

The city of Hawthorne, on the other hand, was located inland, and its people believed that their water supply was protected. Hawthorne adopted a hold-out strategy for many years. Thus, whereas the Raymond Basin case was a guiding model in the minds of the initiators of the litigation, it was not at all certain that the water producers of West Basin would achieve the high level of agreement needed to negotiate their own settlement. Once litigation had been initiated, however, the court could impose its own judgment if the water producers could not reach an agreement on their own. Thus, again the default rule had been changed by the initiation of litigation.

The case was referred to the Division of Water Resources of the California Department of Public Works. The difficult task of ascertaining the production levels for more than 500 producers and determining the geologic structure and inflow levels for a large and complex basin took four years. By the time the referee's report was completed, the decision of the trial court based on the stipulated agreement in the Raymond Basin case had been upheld by the California Supreme Court. Therefore, the West Basin water producers knew that the mutual-prescription concept could withstand a legal challenge by a private company.

The referee's findings and recommendations, however, came as a written bombshell. The referee found that overdrafts had been occurring since 1920 and that the safe yield of the basin was 30,000 acre-feet per year. The referee recommended a curtailment to the safe yield. By 1952, total groundwater withdrawals had reached 90,000 acre-feet per year. Even the supporters of mutual curtailment vigorously opposed a two-thirds reduction in groundwater production. Imported water had just begun to trickle

into the basin. Many water suppliers would not be able to meet their customers' demands if they were to reduce the quantity of water pumped by two-thirds. Early experiments with injection wells provided some encouraging indications that the supply of water to the basin could be increased. An increase in the supply would reduce the necessity of cutting back to the safe yield. The default condition, however, had again been changed. If the water producers were unable to arrive at their own settlement, they could expect the court to order a two-thirds cutback.

The West Basin Water Association provided a forum for serious negotiations about a settlement. The association established a Legal Settlement Committee composed of six attorneys and five engineers. The creation of the Legal Settlement Committee within the association changed the structure of the bargaining situation in subtle but important ways. Although the 11 committee members continued to represent the interests of their own firms, they were accountable to the members of the association as well. The association charged the committee with the responsibility for achieving *timely* curtailment of water production. The committee had to report quarterly to the full membership. The committee members would be subject to public criticism by respected colleagues if they simply pursued recalcitrant strategies and failed to find sources of agreement on which progress toward settlement could be based.¹⁹ The members of this committee were expected to achieve an agreement whereby *all* parties would curtail their withdrawals. The first question to be resolved concerned how much curtailment.

The negotiators had to find a method to reduce withdrawals below 90,000 acre-feet and above the 30,000 acre-feet recommended by the referee. If the negotiated settlement was not above the referee's recommendation, some litigants would prefer to contest the matter in court in the hope that a judge would give their claims precedence over those of others. The engineers on the committee were asked to determine the maximum cutback that the parties could undertake in the near future without grave economic damage. The engineers concluded that a reduction of 25% to 30% could occur without serious economic harm to any water producer, if an exchange pool similar to the one devised in Raymond Basin were established.

Next the committee searched for a particular formula, based on the concept of mutual prescription, that would enable them to achieve a proportional cutback of 25% to 30%. Because 340 additional parties had been added to the case in 1949, one possibility was to use 1949 for determining shares, rather than the 1944 water year that immediately preceded the initiation of litigation. Using the referee's historical findings, the committee

compiled estimates of each party's "prescriptive rights" based on the 1944 water year versus the 1949 water year.²⁰ Their estimates totaled 44,387 acre-feet for 1944 and 63,728 for 1949. The committee proposed to use the 1949 data as the basis for negotiating an *interim* agreement that the parties could ratify immediately in order to achieve an actual cutback within a short time. One member of the committee reasoned that

with the present usage in the amount of 90,000 acre-feet and . . . with the historical usage of 1949 amounting to 63,000 acre-feet or one-half way back to where the Division wanted the curtailment to go, a cutback to 1949 might be more acceptable at the present time . . . [T]he parties would have enough water left under this arrangement to meet peak demands and it would afford a period in which to adjust to curtailment and . . . no one would be giving up any prescriptive rights already acquired.
(West Basin Water Association, Legal Settlement Committee minutes, February 25, 1953, p. 4)

The interim agreement was drafted as a contingent contract. In other words, a water producer who signed the agreement and thus promised to curtail production to his own "Prescriptive Rights, 1949" was not committed to curtail until producers representing at least 80% of the total "Prescriptive Rights, 1949" had signed and the agreement was presented to and approved by the court. A signatory was committed to undertaking this "cooperative action" only if most of the other large water producers were also committed to the action. Thus, no one would be a "sucker," and the joint impact of their curtailments would make a substantial difference. By November 1954, agencies representing 82.5% of the total "Prescriptive Rights, 1949" had signed the agreement, and it was filed with the court. The court appointed the referee to continue as the official watermaster to ensure that the provisions of the agreement were followed.

It had taken two full years of negotiations and the threat of court action²¹ to achieve this interim agreement, but at last a major change in the basic rules affecting the use of West Basin had occurred. Water levels in the basin rose immediately and continued to rise for several years, except in a water trough underlying the city of Hawthorne, which refused to sign the agreement.

The interim agreement was used for seven years while the water producers pursued other strategies to enhance the local water supplies, to replenish the basin, and to try to convince nonsignatories to agree to the curtailment. Two major parties did not sign. The first was the California Water Service Company, which had been one of the three initiators of the litigation and had borne a large share of the cost of the litigation. That company had not increased its water production after 1944, presuming that the litigation had protected its interests and that it could afford to take

an independent action to conserve water supplies. The choice of 1949, rather than 1944, as the date for determining rights meant that some of the water producers who had increased production during the four-year period gained somewhat proportionately, while California Water Service slipped behind a little in its proportionate share.²²

Although it refused to sign the interim agreement, California Water Service Company voluntarily limited its own groundwater production. It did not pump any more water than allocated to it under the interim agreement. Consequently, the effect of the company's refusal to sign the interim agreement was to shift the burden of the cost of watermaster services back onto those who had gained proportionately more rights under the Agreement. The company's actions imposed no physical harm on others. Further, the company clearly did not plan to challenge efforts to make the interim agreement the basis for a final settlement.

On the other hand, the city of Hawthorne increased its withdrawals. By 1960, Hawthorne pumped more than 2,250 acre-feet in excess of its allocation under the interim agreement. During the period of the interim agreement, Hawthorne saved at least \$100,000 by pumping more groundwater per year than it had been allotted. As Hawthorne's production increased, the pumping trough beneath the city continued to drop. The watermaster's report for 1960-1 (plate 4) shows that the 1961 water levels below Hawthorne averaged 30-40 feet below those for surrounding territories (California, State of, 1960-1). Nearby producers were harmed substantially.²³ The economic costs of Hawthorne's action were spread generally among all signatories who paid higher costs for imported water while Hawthorne continued to utilize the least expensive source of water.

From the perspective of Hawthorne's leaders, however, the problem seemed different. Instead of viewing the basin as something jointly owned by all water producers, Hawthorne viewed its needs to serve a municipality with water as superior to the needs of industry in the area. Hawthorne saw the interim agreement as favoring the industrial producers, an effort to take away water rights that should be devoted to public use. Hawthorne looked to other cities for support for its position. However, the beach communities had already suffered severe hardship because of saltwater intrusion. According to Hawthorne officials, those communities were willing to see any basis used to curtail production from the basin and slow down the saltwater intrusion. Hawthorne argued that the beach cities were giving away their rights.

During most of 1957 and 1958, the Legal Settlement Committee met weekly and sometimes biweekly trying to prepare a final agreement. The

technical problems of tracing all water-rights transactions for such a large group delayed the process substantially. The substantive problems were also considerable. Some signatories of the interim agreement opposed any final agreement that would not achieve curtailment down to the safe yield. Others preferred to wait until experiments with the saltwater barrier could establish the feasibility of being protected against the sea. The lack of *total* agreement to the interim agreement disturbed many who feared that Hawthorne or others might appeal. Given the experience of a costly appeal to the California Supreme Court in the Raymond Basin case, negotiators hoped to avoid an appeal of their settlement. Because the interim agreement afforded partial physical protection, many signatories believed that they had time to work out an agreement satisfactory to all parties.

Envoys were sent to the city of Hawthorne to urge city officials to reconsider their previous stance in regard to the interim agreement.²⁴ In 1958, the association appointed the mayor of Hawthorne to its Executive Committee in the hope that he would be able to change the attitude of other city officials. However, the attempts to reach an agreement with Hawthorne were unsuccessful. A final draft of a proposed "Agreement and Stipulation for Judgment" was presented to a meeting of the West Basin Water Association (WBWA) in February 1960. The Dominguez Water Corporation, as the largest water producer from the basin, gave the final agreement its full support by bringing signed copies of the agreement to the meeting. The city of El Segundo and Chanslor-Canfield Midway Oil Company joined Dominguez in this effort to show immediate support (WBWA minutes, February 25, 1960, p. 8). Three months later, 20 parties representing 32.5% of the total adjudicated rights had signed the agreement (WBWA minutes, May 26, 1960, p. 15). Obtaining the remaining signatures took one more year. By early summer of 1961, producers holding 82% of the adjudicated rights had signed the agreement. The Legal Settlement Committee indicated that it was unlikely that further signatures could be gained.

On July 21, 1961, 16 years after the litigation was initiated, a short trial was held, and the proposed judgment was presented to the court. The judgment was entered in August of 1961 substantially as presented to the court. As of October 1, 1961, all entities included as parties in the case were "perpetually enjoined and restrained from pumping or otherwise extracting from the Basin any water in excess of said party's Adjudicated Rights" (Judgment, *California Water Service Company et al. v. City of Compton et al.*, Civil Case No. 506806, Superior Court of the State of California in and for the County of Los Angeles, Sec. 5). Ninety-nine parties were found to

have adjudicated rights of 64,065 acre-feet.²⁵ The city of Hawthorne, like all nonsignatories, was placed under legal order to reduce its groundwater production to that stipulated in the agreement.

At the association meeting following the trial court's decision, a city councilman from the city of Hawthorne rose to congratulate the group on their "victory," but he warned them that his city planned to fight the decision "through every court in the land." The city of Hawthorne backed up that threat by retaining a firm of highly respected attorneys specializing in water law. At first, the association assumed the financial responsibility for supporting the judgment against the Hawthorne appeal. In 1962, when a Replenishment District had been formed, as described later, the new district undertook financial responsibility for defending the judgment, while the association maintained direct relations with the attorneys. After hearing the Hawthorne appeal, the District Court of Appeals concluded that the trial court had acted properly and affirmed its decision. After the California Supreme Court declined to review the decision made by the District Court of Appeals, the California Water Service case closed 18 years after it had opened.

No one really knows the exact costs involved in the West Basin litigation, given the large number of parties and the length of time involved, but the best available estimate is \$3 million (Blomquist 1987a, p. 39). On the one hand, that was 10 times as expensive as the Raymond Basin negotiations. On the other hand, it was one-tenth of costs that would be involved in replacing the short-term storage capacities of the basin when used in conjunction with a surface supply. Amortizing the costs of the litigation over a 50-year period (as one would do for the construction of a major physical facility), the adjudication in Raymond Basin amounted to an annualized cost of 50 cents per acre-foot of water rights allocated, whereas the adjudication costs in West Basin amounted to an annualized cost of \$2.50 per acre-foot of water rights (Blomquist 1987a, p. 39). In 1985, the annual costs of monitoring these water rights were \$3.00 per acre-foot in Raymond Basin and \$2.40 per acre-foot in West Basin.²⁶

Adjudicating the water rights in West Basin was only one of a long series of steps taken by water producers to regulate their basin. Some of the subsequent steps are discussed later. The Raymond Basin and West Basin experiences were closely watched by water producers located in Central Basin. These producers also used court litigation as the setting in which to negotiate settlements of their individual rights to water. Central Basin is larger and more diverse than West Basin. Considerable effort was expended there to learn from the difficulties of the West Basin case and to adopt the process so as to reduce both the length of time needed to achieve

agreement and the high costs. The effort was successful on both counts. We now turn to a brief discussion of the Central Basin negotiation process.²⁷

The Central Basin litigation

Overdraft conditions in Central Basin occurred much later than they had in Raymond Basin and West Basin. Central Basin is quite large (277 square miles of surface area) and was being used by around 750 owners of wells in the 1950s. The overdraft in Central Basin began in 1942. Most of Central Basin is located inland, and it is protected from the ocean on its western border by its downstream neighbor, West Basin. Thus, water producers in Central Basin are able to draw down their water levels farther than are those in West Basin without immediate adverse consequences. On the other hand, Central Basin does have a small southern exposure to the sea, and saltwater intrusion did begin to occur along that boundary as early as 1950.

At the prodding of their downstream neighbors, Central Basin water producers formed the Central Basin Water Association in 1950 using an organizational structure similar to that of West Basin. The part-time executive director of the West Basin Water Association became the part-time executive director of the newly formed Central Basin Water Association.²⁸ Some West Basin water producers were also active in Central Basin. Discussions immediately focused on the importance of achieving a negotiated settlement of the water rights in Central Basin. Central Basin producers, however, wanted to avoid the long delay and high cost of using the court-ordered reference procedure and avoid involving all of the very small water producers in the basin.

Consequently, instead of moving immediately toward the initiation of a suit, the Central Basin Water Association employed the services of a private engineering firm, well known for its expertise in the area of groundwater basins, to conduct an initial survey of conditions in the basin and of past water use. Further, a considerable effort was made to achieve a general agreement about the type of negotiated settlement they would reach before they actually went to court in 1962. An interim agreement, signed by parties holding 79% of the water rights, was approved by the court just 10 months after the litigation was initiated. The producers agreed to cut back production on a proportional basis by 20% and to establish a set of working rules modeled on the West Basin agreement, but also reflecting the particular circumstance in Central Basin. Watermaster services were initiated in October 1962. A voluntary cutback of approximately 45,000 acre-feet was initiated immediately (Fossette and Fossette 1986, p. 182). The

final settlement, signed by parties holding over 75% of the rights, was approved by a judge in October 1965 and went into effect in October 1966 – four years after initiation. The estimated costs of the Central Basin litigation were \$450,000.

The litigation and negotiation processes in these three basins involved different problems and followed different paths. In Raymond Basin, the number of pumpers was relatively small, and one participant – the city of Pasadena – was more dominant than was any participant in West Basin or Central Basin. Pasadena withdrew about one-half of all water obtained from the basin. The city could not ignore the action of the other pumpers, because their actions could adversely affect joint outcomes. However, Pasadena had such a large stake in seeing that the basin was preserved that the city was willing to invest heavily in achieving a settlement. After failing to obtain a voluntary agreement to curtail pumping, the city initiated legal action and bore more than its proportionate share of litigation costs. By initiating efforts to obtain an external water supply and to control pumping from the basin before pumpers had become accustomed to withdrawal far in excess of safe yield, it was physically possible for all pumpers to cut back their water withdrawals and still serve the growing urban population settling in the area. The major asymmetry of interest faced by the litigants in Raymond Basin was their legal status as overlying owners or appropriators. By devising a new legal concept of mutual prescription, the parties found a basis to share the costs of curtailing groundwater production equitably. All pumpers could continue to use the basin for peaking purposes or could sell water rights, which had been well defined, to those who placed a higher value on acquiring such rights.²⁹

Negotiators in West Basin faced three disadvantages not faced in Raymond Basin: (1) the large number of parties involved, (2) the absence of a dominant party, and (3) the asymmetrical risks faced by inland pumpers versus coastal pumpers. The negotiation process took longer, was more expensive, and involved a major conflict between coastal and inland pumpers. By using mutual prescription as the basis for an agreement, the parties reduced other potential asymmetries of interest that could have exacerbated the conflict. Once a final judgment was reached, all parties shared proportionately in the cost of curtailment. The process took sufficient time, however, that it became difficult to cut back to the safe yield and still serve the urban population, which had increased in the years following World War II. As discussed later, water producers in the area had to turn to other mechanisms to increase the supply of water to the groundwater basins, because the control over demand that they achieved did not bring the basin into balance.

Pumpers in Central Basin had several advantages in this process. Because the basin was very large and had only a small coastal section, pumpers could safely delay resolution of their water rights while they watched the process in the other basins. They were prodded into action by their downstream neighbors, who feared that lack of action in Central Basin might eventually negate the benefits of conservation in West Basin. By acting before it would be necessary to cut back much more than 20%, and using a private firm to gather much of the information before they went to court, Central Basin pumpers saved themselves considerable time and money in achieving a negotiated settlement based on the same principle that had been used in Raymond Basin and West Basin.

Conformance of parties to negotiated settlements

Forty-five years have passed since the judgment was entered in the Raymond Basin case, and 35 and 27 years have passed since the interim agreements were signed in West Basin and in Central Basin. Thus, the parties to these three agreements have had many occasions to decide whether or not to comply. Given the value of groundwater, the temptation not to comply must have been relatively great for all producers at one time or another in the combined 107 years of water use that have elapsed. However, the level of infractions has been insignificant during that time.

The watermaster in each basin has extensive monitoring and sanctioning authority. Monitoring activities are obvious and public. Every year, each party reports total groundwater extractions and receives a report listing the groundwater extractions of all other parties (or anyone else who has started to pump). The reliability of these records is high. Several agencies cross-check the records. The watermaster is authorized to calibrate all meters, thereby reducing the probability of one form of cheating. Given the accuracy of the information and its ease of access, each pumper knows what everyone else is doing, and each knows that his or her own groundwater extractions will be known by all others. Thus, the information available to the parties closely approximates "common knowledge," so frequently a necessary assumption for solutions to iterated dilemma games (Aumann 1976).

Instead of perceiving itself as an active policing agency, the watermaster service tries to be a neutral, monitoring agency. Because anyone who possesses a legal water right can initiate a court action to enforce compliance to the judgments, the watermaster does not need to initiate punitive actions against nonconformers. As expressed by an official of the watermaster service in 1960,

it is our policy not to take any affirmative actions against any party since this would place us in the position of being an active party in the action. Our policy has been to inform the active parties of any infringements and leave affirmative action up to them. We want to stay as neutral as possible in order to gain as much voluntary cooperation as possible.³⁰

In the early years of the West Basin agreement, for example, the Moneta Water Company began to withdraw more than its allocation. After a couple of years, it was obvious that the overextractions were not accidental. In addition to listing Moneta's annual withdrawals in the tabular material included in all reports, the watermaster devoted several pages in an annual report to the recent activities of the company. The company began to comply with the judgment soon after the publication of those facts. Other than a few isolated incidents, handled in the same manner, the original litigants have complied with the curtailments without formal sanctions being imposed. Even the city of Hawthorne has curtailed its withdrawals to the stipulated amounts of the final judgment. It has been necessary, however, to initiate legal action against new pumpers who have attempted to withdraw groundwater without first purchasing water rights. Charges have been filed and defendants enjoined from groundwater production other than under the rights they eventually acquired by purchase.³¹

The levels of quasi-voluntary compliance with the final judgments in all of these court decisions have been extremely high. Although each pumper might be tempted from time to time to withdraw more water than legally allowed, each pumper wants total withdrawals from the basin constrained so that access to the storage and flow values of the resource will be continued over the long run. Given the active, reliable, and neutral monitoring of the watermaster service, no pumper can expect to overextract without everyone else learning about any noncompliance at the end of the next water year. Because everyone is organized and communicating with one another about joint strategies, continued noncompliance is likely to bring legal sanctions, as well as loss of reputation and the application of informal sanctions. Because a pumper is constrained, and almost all pumpers voluntarily agreed to the initial allocation of rights, the basic system is perceived to be fair by most participants. Further, participants continue to have control over the monitoring system to ensure that it continues to be active, fair, and reliable. Two-thirds of the watermaster's budget is paid for by those possessing water rights, and they can petition the court to appoint a different watermaster if they are not satisfied with performance.³²

THE ENTREPRENEURSHIP GAME

Immediately after the interim agreement was signed in West Basin, and before litigation was initiated in Central Basin, West Basin water producers recognized that litigation was not a sufficient means to achieve long-term regulation of their basin. They took steps that culminated five years later in the creation of a new public enterprise and a series of agreements with surrounding public enterprises to manage West Basin and Central Basin as interconnected basins. The process of problem-solving and negotiation involved in the establishment of this new district and the series of agreements with existing agencies illustrates how public entrepreneurship can be used as a strategy to transform the structure of incentives facing those jointly using a CPR. The process of putting together the necessary components of a new enterprise was immensely complicated. Only a sketch can be presented here, but I try to present the problems the water producers faced, as they saw them, and the steps they took to try to solve them in the political environment they faced.

The litigation had left several unresolved questions. First, producers had been unwilling to cut back production to the safe yield. Although the cutbacks immediately improved water conditions, they were insufficient to achieve a final regulation of the basins. Either the replenishment of both basins had to be accelerated or further cutbacks in production were needed. If the replenishment rate could be increased, then it would be possible to use the underground storage capacity in a manner somewhat analogous to the use of surface storage facilities, whereby one draws down and then refills the facility repeatedly.³³

A second unresolved, and related, problem was the specific danger that saltwater intrusion posed along the long western border of West Basin and the short southern border of Central Basin. Early in the 1960s, water engineers from West Basin and the Los Angeles County Flood Control District began to experiment with the concept of building a freshwater barrier against the sea. An initial experiment, funded in part by local sources and in part by the state of California, proved that it was both technically and economically feasible to construct a series of wells along the coast that could be used to inject fresh water under pressure into a groundwater basin. The resulting cone of fresh water would prevent further saltwater intrusion. Most of the fresh water would then be available at a later juncture to be withdrawn when needed. If such a barrier could be constructed along the entire coastline, the artificial recharge of the basin would be greatly enhanced, and the threat of the sea would be eliminated. Once the technical and economic feasibility had been established, the

question of exactly who would pay for the barrier, and how, remained to be resolved.

A third delicate question centered on the relevant boundary for managing West Basin and Central Basin. That question had not arisen in regard to Raymond Basin, which was an upland basin and relatively self-contained. Once water producers in West Basin reduced their pumping levels, while water producers in Central Basin continued heavy production, water from West Basin began to flow eastward into Central Basin, instead of westward from Central Basin into West Basin. That change in the direction of the "natural" water flow led producers in both basins to recognize how closely interconnected their two basins were. A barrier erected along the coast would afford protection not only for West Basin but also for Central Basin. Further, an open porous area in Central Basin could be used to replenish far more efficiently than any area located in West Basin. Water spread at that location could raise water levels in Central Basin, which, combined with a cutback in production in Central Basin, would increase the flow of water into West Basin.

No existing public agency had the authority or the appropriate boundaries to address these questions. Water producers in West Basin and Central Basin were reluctant to turn to any of the large-scale agencies currently in existence for fear that they would lose control of the decisions being made and might end up worse off.³⁴ In the fall of 1954, the president of the West Basin Water Association suggested to the president of the Conservation Association of Southern California that there was a need for representatives from all segments of the California water industry to meet and discuss potential legislation for solving critical groundwater problems. As a result, 45 agencies were invited to meet in September of 1954 "to draft equitable and effective ground water legislation for introduction at the 1955 Legislature" (letter from W. S. Rosecrans to the Central Basin Water Association). From that group, the "Committee of Twelve" was formed to draft legislation.³⁵

Discussion of the proposed legislation centered on two types of changes. The first was designed to expedite future groundwater adjudications. The referee in the West Basin case had taken seven years to prepare a report because of lack of information concerning the historical patterns of water use by a large number of the producers. To correct that situation for the future, the committee drafted legislation to require all those who produced at least 25 acre-feet of groundwater per year to file notices of their annual extraction with a state agency. That legislation could not expedite the West Basin case, but it did provide some of the information necessary for relatively rapid adjudications in Central Basin and San Gabriel Basin.

The second area of concern in the proposed legislation involved the authorization of a new type of district empowered to undertake broad replenishment responsibilities financed primarily by a "pump tax" or an assessment on the groundwater production within the boundaries of a district. The legislation as finally drafted was different from what producers in either West Basin or Central Basin might have drafted on their own.³⁶ By taking into account the needs of other areas and existing water service agencies, West Basin and Central Basin producers were able to gain rapid approval of both pieces of legislation when they were submitted to the state legislature in 1955.

The new Water Replenishment District Act authorized citizens located in southern California to create a new district after they had (1) obtained signatures from at least 10% of the registered voters residing within the boundaries of the proposed district, (2) proposed specific limits on the taxing power of the new district, (3) received agreement from the Department of Water Resources that the area included within the boundaries of the district would be benefited by inclusion, and (4) received a majority of positive votes in a special election held to consider the creation of the new district. A district, once created, was given a wide diversity of powers to raise revenue through a pump tax and, to a limited extent, through a property tax and to undertake actions to replenish a groundwater basin. The organic legislation included a unique provision intended "to avoid duplication of similar operations by existing agencies and replenishment district" (*California Water Code*, sec. 60231). The provision stated that

in the event an existing agency has facilities available and adequate to accomplish any part of the purposes of a district . . . the district shall investigate and determine the cost of contracting for the accomplishment of such purposes through such existing agency.
(*California Water Code*, sec. 60231)

In other words, a new replenishment agency would be expected to investigate the costs of contracting to have services provided, rather than immediately creating its own production staff for any activity it wanted to undertake.³⁷ The legislation provided a general "constitution" for a new district. Water producers in any specific area could then use that general framework to create a particular "constitution" for their own district. At first, West Basin producers presumed that they would go it alone and created a working committee within the association to draft a specific proposal to create a district.

The basic issues that had to be resolved in that constitutional process were (1) the source of water for the barrier, (2) the exact boundaries of the new district, (3) how the internal electoral boundaries would be drawn,

Governing the commons

and (4) the extent of taxing powers to be authorized. West Basin water producers had hoped that it would be possible to purchase reclaimed water from the Hyperion water-treatment plant – a sewage-disposal facility operated by the city of Los Angeles – located on the coast. If that had proved technically feasible, they would have had a source of low-cost water and would not have had to negotiate with the powerful Metropolitan Water District of Southern California (MWD). After considerable experimentation, it proved technically infeasible to use the reclaimed water, at least in the short run. The committee had to start over again. Members of both associations were appointed “to approach the Metropolitan Water District . . . to see whether a firm commitment of a sufficient quantity of water could be obtained . . . and to request a certain amount of engineering and costs estimates which would be needed” (report by Allan Harris, West Basin Water Association, minutes, March 22, 1956, p. 6).

Once West Basin producers realized that they would have to use MWD water for the barrier, they began more intensive talks with their Central Basin neighbors concerning the creation of one large district to include both basins. When the two associations first started discussions, the differences between the two basins were quite apparent. West Basin was smaller in area, population, and assessed valuation. In a joint district, it could be dominated by Central Basin. In 1955, West Basin producers had signed the interim agreement and had limited their production to 60,000 acre-feet per year, whereas Central Basin producers were pumping 110,000 acre-feet and still increasing their annual rates of withdrawal. At a meeting of the West Basin Water Association, the chairman of the committee devising the proposal outlined the reasons for and against forming a district to include both basins.

Reasons for forming a district to include both basins

- 1 The purpose would be the same in both basins: replenishment of the groundwater supply.
- 2 Greater financial resources would be available; hence, the tax rate and amount of pumping assessment could be lower.
- 3 A large district would have greater political strength and would be more effective in dealing with the Upper San Gabriel Valley District and various state bodies.
- 4 The Long Beach harbor area offers a potential route for intrusion of seawater into West Basin and probably would be included. It is doubtful that any of Long Beach could be included in a district comprising only the West Basin.

Analyzing institutional change

- 5 The flow of groundwater across the fault from Central Basin to West Basin probably would be greater under the replenishment program of a larger district.
- 6 Administration costs would be less in a larger district.

Reasons against forming a district to include both basins

- 1 The injection of replenishment water would be unique and necessary to West Basin. Central Basin would control that program in the West Basin if a large district were formed and might not want to continue the well-injection method along the coast.
- 2 Pumping was curtailed in West Basin, but not in Central Basin.
- 3 The degrees of ultimate curtailment might not be the same in the two basins.
- 4 Control of the local tax rate and amount of pumping assessment would be relinquished by West Basin.
- 5 A local district could initiate proceedings to ensure financial replenishment from Central Basin.³⁸
- 6 Extensive recharge of Central Basin might contribute free water to West Basin (West Basin Water Association, minutes, November 17, 1955, pp. 9–10).

The West Basin water producers were physically disadvantaged because they were at the end of the groundwater “pipeline.” They were concerned that their physical disadvantage could be exaggerated by the creation of a new public agency in which they would be politically dominated. The hopes and fears of West Basin producers were summarized in a letter written by the chairman of the West Basin committee to his committee:

In the event a water replenishment district to include both Basins is decided upon, it appears desirable that a statement of policy morally binding on the new district board of directors should be adopted. The policy should provide assurance of an effective salt water barrier program for West Basin, a curtailment of pumping in Central Basin to insure continued ground water flow into West Basin, and an arrangement of the five divisions of the new district so that territory of both Basins would be included in each such division to prevent West Basin versus Central Basin representation on the board of directors.

(letter from R. R. Thorburn to the Replenishment District Boundary Committee, October 27, 1955, p. 2)

Soon thereafter, members of both associations came to a working agreement that the benefits of a larger district would outweigh the costs. Assurances were given to West Basin producers that they would not be

dominated by their eastern neighbors. Next, a joint committee of both associations began a series of relatively tough negotiations with all of the public agencies that might eventually be involved in managing these two basins.³⁹

The results of those negotiations were formalized in a seven-page proposal that the committee submitted to the two associations for approval in August of 1958. The proposal set forth the essential factors for constituting the new enterprise. The statement proposed that a new replenishment district would be formed to (1) repel saltwater intrusion, (2) recharge the groundwater basins, and (3) reduce pumping in the basins to safe limits (West Basin Water Association and Central Basin Water Association, "Proposal Submitted by the Joint Committee on Water Replenishment District," mimeograph, July 30, 1958, p. 1). The proposal stated that to accomplish those purposes, "the district will have responsibility for financing the purchase of water used in halting the intrusion of sea water and in replenishing the groundwater supply" (ibid., p. 3).

The proposal then clarified the future relationships of the replenishment district to all of the existing agencies that might consider the replenishment district to be a potential competitor. It then outlined the amount of water that would be purchased from MWD and spread or injected by the Los Angeles County Flood Control District. The proposal stated that the new district "would have no authority to purchase replenishment water with *ad valorem* tax derived funds, and the petition for the formation of the district will clearly set forth this limitation on its taxing power" (ibid., p. 6). It was estimated that a levy of \$6.00 per acre-foot would be necessary to raise the necessary funds to purchase 165,000 acre-feet of water from MWD – an amount equal to the average annual overdraft. The proposal concluded by stating that the new district would be "an administrative agency operated by a five-member board of directors with a minimum staff" (ibid., p. 7).

The proposal was in effect a "constitution" for a multiple-agency management system to operate a coordinated program. Constitutional documents do not need to carry the formal name "constitution" to serve the purpose of determining the decision rules to be used for making future collective choices about some specified physical domain. The proposal was attached to the formal petitions presented to the Los Angeles County Board of Supervisors (to gain approval for the special election) and to the California Department of Water Resources (to gain approval for the boundaries), and in that way had formal recognition as a type of constitutional document. Once that constitution had been approved by the two private associations, all formal steps outlined within it were achieved within a few months, and the Central and West Basin Water Replenishment District was

supported in the election of November of 1959 by a vote of 4 to 1 (*Los Angeles Times*, November 18, 1959).

THE POLYCENTRIC PUBLIC-ENTERPRISE GAME

The creation of the Central and West Basin Water Replenishment District in 1959 dramatically transformed the structure of incentives facing water producers and their representatives. It was an enterprise created by the water producers (and approved by the citizens living in the area), with public powers to tax, to sue, and to engage in the provision of collective goods. Whereas the replenishment district took over the *active* role of managing West Basin and Central Basin, the two private water associations continued to have strong input into all policy decisions.

Further, the replenishment district is only one public enterprise among a half dozen agencies that are actively involved in the management program. Thus, instead of one central governmental authority, a polycentric public-enterprise system has emerged to achieve a very sophisticated management system. This polycentric system has restored water levels throughout both basins, has completed a freshwater barrier along the exposed coasts of both basins, and is now engaged in focused efforts to eliminate pumping troughs and other physical impediments that inhibit the effective use of the basins in conjunction with a surface supply.

The overall costs of this system are quite low.⁴⁰ In Table 4.1, the amortized and annual costs (in constant dollars) of the management systems in these basins, as computed by Blomquist, are contrasted with the amortized costs of replacing the basins with surface storage. Total costs are substantially lower in each basin than they would be if the basins had been destroyed. Total costs would, of course, be lower if water producers had been able to negotiate a settlement of their water rights at an earlier juncture and had not had to pay the high costs of prolonged negotiations. The water producers of Central Basin, however, learned from the experiences of their colleagues in Raymond Basin and West Basin and thus were able to achieve a settlement at lower costs.

In this discussion I have tried to focus more on the origins of these institutions than on their current operations, because it is so difficult to find documentation about the origins of institutions. I do think it is important, however, to describe briefly the types of polycentric relationships that exist among the public enterprises that currently manage West Basin and Central Basin.

At the core of each of those relationships is the Central and West Basin Water Replenishment District. This district receives the funds assessed on

Table 4.1. *Basin management costs and savings per acre-foot resulting from basin management in the three basins (dollars)*

Cost	Raymond	West	Central
Basin management cost per acre-foot of ground-water extraction, 1985	3.50	77.40	73.77
Average cost of an acre-foot of water with basin management	184.65	235.71	224.85
Estimated cost of an acre-foot of water if all groundwater were replaced by imported water	748.68	739.30	739.94

Source: Adapted from Blomquist (1987a, Figure 9).

all water pumped in the district and thus has the power to take collective action for both basins. To get the water into the basins, however, the replenishment district must relate to several other public districts. Until the late 1960s, the replenishment district depended on a monopoly supplier of water, the MWD, for its replenishment water. In 1966, MWD unilaterally announced a change in its pricing structure that would substantially increase the cost of replenishment water. The replenishment district and both associations bargained hard, but unsuccessfully, for a reconsideration. The replenishment district then opened negotiations with the Los Angeles County Sanitation Districts to obtain a reliable supply of water at lower cost from a specially constructed reclamation plant.⁴¹ Opening this alternative source of water supply has meant that the replenishment district has assured itself of a continuing supply, and at a cost well below that of imported water. In 1987, for example, the district was seeking approval from the relevant regulatory agencies to increase its purchase of reclaimed water from 30,000 acre-feet per year to 50,000 acre-feet per year, at an average cost of \$8.00 per acre-foot, as compared with the \$1.53 it has to pay MWD for replenishment water (Central and West Basin Water Replenishment District 1987, pp. 44–56).

In regard to the actual operation of the replenishment works, the replenishment district entered into an exchange agreement with the Los Angeles County Flood Control District (reorganized in 1987 to be the Los Angeles County Department of Public Works). Thus, the replenishment

district has maintained only a skeletal staff (an executive director and a secretary), rather than employing its own engineering staff. The county cannot exert full monopoly power in its supply of replenishment services, because the replenishment district has access to several other potential suppliers and could always create its own staff to undertake the replenishment activities.⁴² At one point when the replenishment district was particularly unhappy with the progress of some construction work undertaken by the county, the replenishment district was able to use its bargaining power to insist that a portion of the design for one of the barriers be contracted out to a private firm.

The watermaster service of the California Department of Water Resources performs an essential service for the replenishment district and the producers by monitoring the extractions by producers. Two-thirds of the cost of this service is paid for by the producers. If these costs become too high, the producers can petition the court to assign some other agency – public or private – to be their watermaster.⁴³ The replenishment district and the watermaster service have entered into cooperative agreements to reduce duplication in their activities. Records of withdrawals submitted by groundwater users to the replenishment district as the basis for taxation are also made available to the watermaster. Instead of relying strictly on hierarchical relations, as within a single firm, the management system is governed by negotiation and bargaining processes among many different actors in several different arenas. Strict majority-rule procedures are rarely used in any of the decision arenas governing this system.

In addition to the public districts, private water associations remain active in each of the basins. Public officials are asked to make frequent reports to the regular meetings of the water associations. The water engineers of the private and municipal agencies who attend these meetings tend to ask tough questions and want reasoned answers. They have access to independent information about conditions and are not satisfied by stylized responses that provide little information. Many of the individuals who are elected to office in the public districts have been active in the water associations for many years. Their tenure in public office tends to be long, and normally they are active in one or another public or private role for a quarter of a century.

This brief sketch of the patterns of relationships among public enterprises illustrates how a governance system can evolve to remain largely in the public sector without being a central regulator. Aspects of both private and governmental activities are involved in all of these basins. Some scholars have characterized the assignment of well-defined rights to the flow of a

CPR as "privatization." Given that the water rights held by water producers are now entirely separable from land and are well defined, a market for water rights has evolved in each of these basins, and rights are actively transferred. But that is only part of the story. No one "owns" the basins themselves. The basins are managed by a *polycentric set* of limited-purpose governmental enterprises whose governance includes active participation by private water companies and voluntary producer associations. This system is neither centrally owned nor centrally regulated.

Although the solution to the problems facing these groundwater producers did not involve either a central regulator or a private-property system, it did involve creating an institutional arrangement that incorporates the full set of design principles discussed in Chapter 3. Well-defined boundaries were achieved through litigation. Viewing this set of institutions together,⁴⁴ it can be seen that congruence between appropriation and provision rules and local conditions has been achieved. Collective-choice arrangements are provided by the voluntary associations and by the special districts so that most pumpers can actively participate in the modification of rules as needed. The court-appointed watermaster has considerable monitoring powers and issues annual reports that give all participants accurate information about rule compliance and water conditions. The informal sanctions that have been utilized to encourage rule conformance have, in the main, been modest. Formal sanctions are available for use if they are needed. The continuing jurisdiction of the court and the regular meetings of the voluntary water associations provide conflict-resolution mechanisms. The legal structure of the state of California recognizes the rights of pumpers and others to organize, and the organization units are nested within larger units. Given the stability that these institutions have demonstrated thus far, and their conformance with these design principles, I believe that these CPR institutions are robust and will survive for a long time to come.

THE ANALYSIS OF INSTITUTIONAL SUPPLY

In this chapter I have described several efforts to solve second-order collective dilemmas. A pumping race is the first-order dilemma facing pumpers from a groundwater basin where legal rights to withdraw water are not limited. Each pumper has a dominant strategy to pump as much water as is privately profitable and to ignore the long-term consequences on water levels and quality. The experience in all of these groundwater basins illustrates how a pumping race can continue for many years, even though water levels fall (raising everyone's costs of lifting water) and salt water intrudes

(threatening the long-run survival of the basin itself). Overdraft conditions continued for several decades in these basins. The best explanation for the actions and outcomes during that period is that individuals caught in a pumping race will select their dominant strategy to pump as much as is privately profitable and ignore the consequence for themselves and others.

Given the initial empirical support for this prediction, it is easy to see why theorists would also predict that individuals caught in such situations would refrain from investing resources in designing, negotiating, and supplying new institutions. If pumpers will not limit their groundwater production, why should they invest in the provision of new institutions? The effort to supply institutions is described as simply a second-order dilemma that is no more solvable than the first-order dilemma. The prediction that appropriators will not expend resources to supply new institutions is, however, not supported by these case studies.

These groundwater pumpers invested heavily in the supply of institutions. They created new private associations. They paid for costly litigation to allocate water rights. They drafted legislation, had it introduced to the state legislature, and gained sufficient support from other water enterprises to get the legislation passed. They created special districts to tax all the water they withdrew from the basins, as well as the property overlying the area. They spent seemingly endless hours informing themselves about the structures of their basins, the various concerns and intentions of all parties, and future possibilities.

Incremental, sequential, and self-transforming institutional change in a facilitative political regime

The substantial investments that these groundwater pumpers made in providing new institutions occurred in an incremental and sequential process in the state of California – a home-rule state – where many statewide institutional facilities are provided to reduce the costs of local institutional supply. The investment in institutional change was not made in a single step. Rather, the process of institutional change in all basins involved many small steps that had low initial costs. Rarely was it necessary for participants to move simultaneously without knowing what others were doing. Because the process was incremental and sequential and early successes were achieved, intermediate benefits from the initial investments were realized before anyone needed to make larger investments. Each institutional change transformed the structure of incentives within which future strategic decisions would be made.

Further, because the appropriators from several neighboring basins were

all involved in similar problems, participants in one setting could learn from the experiences of those in similar settings. Sufficient overlap existed among participants across basins to ensure communication about results. Interbasin coordinating arenas were created at several junctures to enhance the ability to exchange information about agreements reached within and across basin boundaries.⁴⁵

In each basin, a voluntary association was established to provide a forum for face-to-face discussions about joint problems and potential joint strategies. Given the uncertain legal structure, attorneys advising water companies and public utilities had consistently advised their clients to pump as much water as they could profitably use and worry about defending their water rights later. The provision of a forum for discussion transformed the structure of the situation from one in which decisions were made independently without knowing what others were doing to a situation in which individuals discussed their options with one another. Discussion by itself was not sufficient to change the pumping strategies of the participants, but discussion did lead to the initiation of litigation, which enabled the participants to reach an enforceable agreement to limit their water withdrawals.

Further, the voluntary associations provided a mechanism for obtaining information about the physical structure of the basins to be made available to all pumpers simultaneously. Prior to that investment in information, no one had a clear picture of the boundaries, demand patterns, and water levels throughout a basin. One knew only that the water levels in one's own wells were falling. No one knew the extent of saltwater intrusion or the total quantity of water withdrawn from the basin. The private associations provided a mechanism for sharing the costs and the results of expensive technical studies. By voluntarily sharing the costs of providing information – a public good – participants learned that it was possible to accomplish some joint objectives by voluntary, cooperative action. The membership dues for the associations were modest and were allocated in rough proportion to the amount of water an enterprise withdrew from a basin.⁴⁶ By spending time to attend meetings, members gained considerable information about the condition of their basins and the likelihood that others would commit themselves to follow different strategies in the future.

Whereas the voluntary associations provide a mechanism for sharing costs, the state of California provides facilities that help reduce the level of those costs. Maintaining a court system in which individuals have standing to initiate litigation in order to develop firm and transferable rights to a defined quantity of water is one such contribution. The state of California goes even further and subsidizes one-third of the cost of such litigation in

order to encourage full exploitation of water resources and settle disputes over water rights when necessary. The Department of Water Resources has provided technical assistance throughout the period, as has the U.S. Geological Survey.

The general home-rule tradition that is built into the state constitution and legislative practices in the state also helps reduce the costs of transforming existing rule systems. It is relatively easy for a group of individuals to introduce new organic legislation authorizing a new type of special district, but state legislators will rarely support such proposed legislation when there is substantial opposition to it in the state. But when individuals in one area have discussed such proposals with others who are likely to be affected, organic laws frequently are passed with close to unanimous support.

In other words, the rules for engaging in microconstitutional choice related to the control of groundwater have encouraged investments in self-organization and the supply of local institutions. A similar set of individuals facing similar problems in an entirely different type of political regime might not be able to supply themselves with transformed microinstitutions. The difference between an active effort by a central government to regulate appropriation and provision activities and an effort to provide arenas and rules for microinstitutional change is frequently blurred.

Reformulating the analysis of institutional change

Trying to understand the incremental, sequential, and self-transforming process of institutional change in these groundwater basins leads me to suggest that institutional analysts should reconsider the ways in which they conceptualize the problem of supplying institutions. Such a formulation should involve several subtle but important changes in the way analysts think about institutional rules, their origin, and their changes. An important step is to assume that all recurring situations are shaped by a set of institutional rules. Institutional rules are prescriptive statements that forbid, require, or permit some action or outcome (E. Ostrom 1986a). One of the three deontic operators – forbid, require, permit – must be contained in a statement for it to be considered a rule.⁴⁷ All three deontic operators are used in this definition of rules.⁴⁸

Some analysts limit their conception of rules to prescriptive statements containing only required or forbidden actions and outcomes.⁴⁹ With that limited conception, some recurring situations are rule-governed, and others are not. By including all three deontic operators in a definition of a rule, it is always possible to identify the set of rules that constitute a situation.

One needs to ask only two questions concerning the actions and outcomes of relevance to this situation: (1) Is this action or outcome (or its negation) required? (2) Is this action or outcome (or its negation) forbidden? Any action or outcome (or its negation) that is not required nor forbidden is permitted. Consequently, the absence of a rule forbidding or requiring an action is logically equivalent to the presence of a rule that permits an action. Hobbes's state of nature is a situation in which no rules requiring or forbidding any actions or outcomes are present. The Hobbesian state of nature is logically equivalent to a situation in which rules exist permitting anyone to take any and all desired actions, regardless of the effects on others.

Usually it is possible to answer the two foregoing questions regarding any recurring situation that is sufficiently structured that one can analyze it. Consequently, for any such situation, one can identify a set of status quo rules related to the situation. Status quo rules continue in effect until changed. The status quo rules in a Hobbesian situation can be viewed as a set of default rules by which everything is permitted (Gardner and E. Ostrom 1990). Similarly, a CPR situation in which no one is forbidden or required to take any action is logically equivalent to a CPR situation in which everyone is permitted to take any and all actions. The rules governing such a situation are all default rules.

Once one assumes that all recurring situations are characterized by a set of status quo rules, then it is possible to broaden the concept of institutional supply to include both what can be called the "origin" of new institutions and the changing of existing institutions. The origins of institutions and changes in institutions frequently are considered to be fundamentally different.⁵⁰ In this view, origin is characterized as a situation in which individuals move from having no rules to having a set of rules. In such a view, the origin of institutions is thought of as a major, one-step transformation, whereas institutional change is viewed as involving incremental changes in existing rules.⁵¹ Supplying new institutions is consequently viewed as non-incremental and costly, whereas changing existing institutions is viewed as incremental and not as costly.

Both origins and changes in institutions can be analyzed using the same theory when both are viewed as alterations of at least one status quo rule.⁵² A change in any rule affecting the set of participants, the set of strategies available to participants, the control they have over outcomes, the information they have, or the payoffs (E. Ostrom 1986a) is an institutional change. The costs of changing the rules vary substantially from one rule to another, from one political regime to another, and from one level of analysis to another, and they also vary over time as participants and conditions

change. Whether or not it will be costly to achieve any institutional change will depend on many variables (to be discussed in Chapter 6), not simply on whether or not a new institutional arrangement is being created.

The creation of a new institutional arrangement can sometimes be quite easy and involve little cost. In the cases discussed earlier, for example, creating new voluntary associations to discuss common problems did not involve major investments by any of the participants. On the other hand, creating the Central and West Basin Water Replenishment District involved major investments in time and money. Transforming existing rules can also be very costly. Changing the water rights for overlying and appropriative water producers, for example, involved many years of costly litigation. All of these rule changes were crucial aspects of the process of institutional supply in these cases. Each built on the base of prior rules. That some rule changes could be undertaken with low transformation costs enabled the participants to gain some advantages of collective action before they were faced with more costly alternatives. All of these transformation costs are affected by the surrounding political regime. After several decades of institutional change, the resulting institutional infrastructure that had been created represented a major investment that dramatically changed the incentives and behaviors of participants and the resulting outcomes. Each institutional change became the foundation for the next change.

What is presumed to be a second-order dilemma, in which institutional change is viewed as one large step, may or may not have the structure of a dilemma when institutional change is viewed as a sequential and incremental process. The net payoffs of solving a small part of a large second- or third-order problem may be sufficiently high and distributed in such a manner that some participants will voluntarily provide initial second-order collective benefits, whereas they are unwilling to provide first-order solutions on their own. Solving some initial second- and third-order problems can help participants move toward solving first-order problems, as well as the more difficult second- and third-order problems.

With these conceptual revisions, it is possible to move toward the development of a single theory of institutional change, rather than one theory about origins and another theory about reform. Both constitutional-choice and collective-choice processes produce rules affecting the behavior of actors in linked situations (see Figure 2.2). Both constitutional-choice and collective-choice processes are themselves structured by rules. In a constitutional-choice situation, individuals decide whether or not to change a set of status quo rules that determine who is eligible and how future collective-choice decisions are to be made. Similarly, in a collective-choice situation, individuals decide whether or not to change a set of status quo

rules that determine who is eligible and how future operational choices are to be made.

The outcome of a collective-choice process frequently is conceptualized as a "policy space," leaving unspecified what is contained in that policy space. When a budget is to be determined in a collective-choice arena, the policy space can be thought of as a set of rules concerning who is required, forbidden, or allowed to spend how much money for what purpose during what time frame. When a regulation is to be determined, the policy space can be thought of as a set of rules concerning who is required, forbidden, or allowed to take what action or affect what outcomes related to a specific domain.

In both processes, individuals compare the net flows of expected benefits and costs to be produced by the set of status quo rules, as compared with an altered set of rules. To explain institutional change, it is therefore necessary to examine how those participating in the arenas in which rule changes are proposed will view and weight the net return of staying with the status quo rules versus some type of change. In Chapter 6, I shall develop these ideas further and present the rudiments of a theory of institutional change applicable to the changing of rules that structure collective-choice or operational-choice situations. Before I do that, however, it is important to examine the failure cases discussed in Chapter 5 so that these conjectures can also build on information from situations in which participants were not successful in changing their institutions.