

Crafting Water Constitutions in California

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ABSTRACT

Water resources must be governed before they can be managed, and the crafting of governance institutions is an ongoing challenge of the human condition. Institutional artisanship requires the availability of tools for institutional design and creation, and a reflective understanding of the use of those tools. Yet neither the tools nor the understanding exist in their entirety before institutional artisans attempt their craft: the tools at hand must be adapted to new purposes, and skill in their use must be learned along the way. Errors are inevitable, but successes are possible. These insights, drawn from Vincent Ostrom's work on understanding human action, are applied in this paper to the development of institutional arrangements for the management of water resources in California.

Water management requires a clear understanding of the diverse ways in which collective efforts can be organized to construct institutions to solve problems. Vincent Ostrom's work to date has aided and encouraged scholars from several disciplines to see the development of institutions—including the construction of constitutions—in many settings besides the well-known formal documents of central governments. His work has also underscored the capabilities and limitations of fallible human beings as they engage in the tasks of constitution making. Vincent and Elinor Ostrom have drawn many scholars' attention to the management of water resources as an exercise in individual and joint action in the development and maintenance of institutions. As Vincent Ostrom (1962: 450) has pointed out, "Few areas... offer a richer variety of organizational patterns and institutional arrangements than the water resource arena."

The institutional arrangements for governing and managing water resources in California have emerged through problem-solving and constitution-making processes that required considerable investments in information gathering and arenas for communication and deliberation. This paper summarizes prior research by the author (Blomquist 1992) on how boundedly rational, fallible water users in California formed those institutional arrangement—creating constitutions, so to speak, for a number of California’s river and groundwater basins.

These processes of institutional design and development were marked by innovation, adaptation, learning, and entrepreneurial skill. The processes were facilitated by the freedom of individuals to form associations and the experience they gained in doing so, the home rule tradition of the State of California with respect to the formation and activities of local governments, and the availability of courts with equity jurisdiction. The processes were constrained by California water law, by the physical characteristics of the groundwater basins and what they could and could not do in the way of providing the desired supplies, by the southern California climate, by the fact that the existing political jurisdictions did not necessarily corresponding to the boundaries of natural physical systems, by existing or simultaneously developing arrangements for land use and wastewater collection and discharge, by state and federal projects such as the State Water Project and the Central Valley Project, and by the patterns of past institutional development. As is usually the case in institutional creation, some problems emerged in the wake of efforts to solve others, and the options that were available at a given moment were largely the result of choices made in the past.

The governance systems and management organizations that were produced by these processes were put together deliberately, and are composed of myriad organizations and inter-organizational arrangements and rules to govern the behavior of water users. They are, in other words, polycentric. One could argue that at least as much of social behavior is conducted in polycentric systems such as associations, covenants, contracts, and inter-organizational arrangements as in either markets or hierarchies. Normatively, polycentricity offers better prospects for yielding self-governing systems that match the capabilities of human beings (who are neither automatons nor omniscients).

We still know too little about polycentric structures: how they develop, how they are organized, and how they perform. But we know more than we would have without the work of Vincent Ostrom, and we know more about which questions to ask and what methods to apply as we work to understand them further. Tocqueville urged humankind to develop a "new science of politics" based on a "science of association" in order to understand the governance of democratic societies, and the kinds of questions we ask as a result of Vincent Ostrom's influence have taken us far in the development of those sciences.

Institutional arrangements are designed, redesigned, adapted, and eliminated over time as part of a problem-solving process. They can be understood in terms of deliberate choices made within constraints by human beings with limited capabilities in a changeable world. The institutional arrangements for managing groundwater and river basins in California evolved from processes of human problem solving over a number of years.

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Development of Water Problems and Organizations in Southern California to the 1930s

We begin in the valley of the San Gabriel River in Southern California. The boom of the 1880s triggered disputes over rights to surface water supplies. Conflict over access to waters of the San Gabriel River continued until several prominent valley men negotiated an agreement known as the Compromise of 1889. The compromise divided the San Gabriel River water among its claimants, and established the San Gabriel River Water Committee (the "Committee of Nine"). The committee was composed of representatives of the disputing claimants and administered the provisions of the Compromise of 1889, maintaining a self-governing system along the river for several decades.

The real-estate boom exhausted itself in the late 1880s and collapsed. Southern California continued to add new residents, but the pace of growth cooled substantially. During this period, some mutual water companies and irrigation districts that had developed surface water ditches and canals failed during the 1890s, and a drought set in during the decade that dried up streams in several locations. Groundwater wells became vital to the survival of many farmers and communities, and as early as 1904 groundwater declines were being documented in official reports.

Water users responded to the drought in various ways. Los Angeles municipalized its water-supply system, taking it back from the Los Angeles Water Company in 1902, and continued legal actions against upstream pumpers and diverters. In the San Gabriel Valley, Pasadena began spreading water at the mouth of Arroyo Seco canyon. In the Santa Ana River watershed, water users in the northwest portion of Chino Basin began to spread San Antonio Creek waters in 1895 and organized the Pomona Valley Protective Association to oversee the activity. The Gage Canal Company, and the East Lugonia

Mutual, San Antonio, Etiwanda, Cucamonga, and Fontana Union water companies began similar operations in 1903 (Scott 1977: 222). On the Coastal Plain, the Irvine Ranch Company began spreading water from Santiago Creek for storage in 1896.

After the drought ended, the development of water management schemes and of water governance institutions continued. Complementarities were identified and exploited between the desire for greater water retention and the need for improved flood control. For example, in 1908 the U.S. Army Corps of Engineers rechanneled the Santa Ana River on the Orange County Coastal Plain in an attempt to reduce future flood damage. In June 1909, the Tri-Counties Water Conservation Association (Orange, Riverside, San Bernardino counties) was formed to attempt surface water retention and groundwater replenishment on a basin-wide scale in the Santa Ana River watershed, authorizing the construction of a dam and diversion canal on the river, and spreading operations were under way by 1911. After a destructive flood in 1914, the Los Angeles County Board of Supervisors sought approval from the state to create a flood control district. The Los Angeles County Flood Control District was created in 1915 and soon undertook several projects to rechannel and control the flows of the Los Angeles and San Gabriel Rivers, as well as the Rio Hondo and some of the tributary streams in the county. These structures were incorporated into replenishment and storage operations that began shortly afterward.

In the San Gabriel Valley, Pasadena had been spreading water at the mouth of Arroyo Seco canyon since the drought years of 1895-1904, recharging the Raymond Basin from which the city drew most of its municipal water supply. Observing the Los Angeles experiment with importing water, Pasadena's leaders were convinced that an outside

water source was a desirable means to assure future growth. If Los Angeles could bring water from the Owens Valley to the San Fernando Valley, Pasadena would bring water to the San Gabriel Valley from some similarly underdeveloped source on the other side of the mountains. In 1920, the city of Pasadena proposed to divert water from the headwaters of the Mojave River and transport that water over the San Gabriel Mountains for municipal use in the Raymond Basin. Pasadena filed an application with the California Division of Water Rights, but the application was denied after land and water companies, irrigation districts, and farming associations in the Mojave River area organized and opposed the move.

Pasadena's forays in search of additional water supplies were motivated by necessity as well as invention. By the mid-1920s, another dry cycle was underway in southern California, which lasted through 1937. The dry period was not as severe from year to year as the 1895-1904 drought, but it presented serious water-supply problems nevertheless, since three times as much acreage was developed and in need of regular water service as had been under use in 1904.

New deep-well turbine pumps could extract larger quantities of water more rapidly and from greater depths than the mechanical pumps of the late 1800s. They made it possible to develop more acreage, but increased the overall draft on groundwater supplies. In 1912, the Southern California Edison Company had to abandon a well at Redondo Beach because it was pulling salty water. By the late 1920s, it was apparent that the Redondo Beach occurrence had been a warning, not a fluke. Salt-water intrusion, declining water levels, and vacant groundwater storage capacity appeared in report after report through the 1920s and 1930s.

Works were constructed along the San Gabriel and Santa Ana Rivers and all tributary creeks and washes with the intention of keeping every drop that fell from the sky or trickled down the side of a hill or mountain from reaching the ocean without first having been caught, diverted, spread, sunk underground, pumped out for use on the land and preferably returned underground for reuse downstream. Additional water users' organizations, such as the San Gabriel Water Spreading Corporation, the San Gabriel Valley Protective Association, and the Chino Basin Protective Association formed during this period. These groups added their efforts to those of the Tri-Counties Water Conservation Association in the Santa Ana River watershed, the Los Angeles County Flood Control District in the San Gabriel River watershed, and the city of Los Angeles in the Los Angeles River watershed.

Other efforts were focused on bringing more water to the region. In 1923, at the suggestion of William Mulholland, the local hero of the Los Angeles Aqueduct, the Los Angeles Department of Water and Power conducted preliminary studies of the possibility of constructing an aqueduct across the desert to the Colorado River. In 1924, Los Angeles filed for and was granted rights to 1,500 cubic feet per second of Colorado River water. This time, however -- for a variety of reasons that included the enormous expense of the undertaking, the amount of supplemental water potentially available, and the fact that the water supply situation of other southern California cities was even more precarious than that of Los Angeles -- the city decided not to go it alone. Such a project could be financed and operated by a new public organization, a unit of local government that would itself be composed of local governments.

State legislative authorization was secured for creation of a "metropolitan water district." This new jurisdictional creature would be governed by a board composed of representatives of the participating local government units within its territory, where "participating" meant paying the costs of financing the district's operations -- which would initially be financed through bond sales, secured against the valuation of real property in the participating localities. Originally, the cities of Anaheim, Beverly Hills, Burbank, Colton, Glendale, Los Angeles, San Bernardino, San Marino, Santa Ana, and Santa Monica joined the district along with Pasadena. San Bernardino and Colton subsequently withdrew from the organization, but Compton, Fullerton, Long Beach, and Torrance took their places. In all, thirteen cities became "charter members" of the Metropolitan Water District of Southern California, the MWD. In September 1931, the MWD Board agreed to submit to voters in the thirteen cities a bond issue for the whopping Depression-era sum of \$220 million. The bond issue passed in November 1931 by a combined margin of 5 to 1. Construction of MWD's Colorado River Aqueduct began in December 1932 and was completed in June 1941, for a total cost approximately 20 percent less than estimated (MWD 1962: 14).

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A Groundwater Basin Constitution in the Raymond Basin

At considerable expense to its taxpayers, Pasadena had taken a number of actions for its own benefit and to the benefit of basin water conditions, including the water-spreading operations and the acquisition of supplemental water supplies from the San Gabriel River and then the Colorado River. Nevertheless, water levels at the city's wells continued to fall, dropping more than 100 feet between 1922 and 1937. Pasadena officials called

together other known Raymond Basin producers, reviewed the published reports of the Division of Water Resources, as well as Pasadena's own information about the basin, and attempted to negotiate a pumping reduction on a cooperative rather than an adversarial basis. These efforts failed, and city officials contemplated legal action (Sopp 1943: 431; Blackburn 1961: 3).

Pasadena officials had reached the limits of their willingness to act alone. The city reduced pumping somewhat when it began to receive additional supplies from the San Gabriel River in 1935. But to redress the overdraft on its own, Pasadena would have to cut its production by one-half and import substantially more expensive Colorado River water from MWD when available, while other basin users continued to meet all their needs with less expensive groundwater—a classic collective-action sacrifice Pasadena was unwilling to make.

Pasadena chose instead to initiate proceedings in Superior Court against the city of Alhambra and other major Raymond Basin water users. The action sought to adjudicate and quiet title to Pasadena's rights in the basin, and to enjoin the annual overdraft. The court directed the city to amend its complaint to name as defendants all entities in the basin pumping more than 100 acre-feet annually; there were 30.

The Significance of Courts with Equity Jurisdiction. Water users such as Pasadena found it advantageous to address their water problems through the California courts for a number of reasons. Court action could encompass all relevant participants, but only the relevant participants, in sorting out the dispute and resolving it authoritatively. In other words, through court action the water users could define the boundaries of the basin

"community." Within that institutionally defined community, agreements could be negotiated and actions taken for the basin as a whole.

In the California court system at the time, any civil court could function as a court of equity as well as a court of law. Equity jurisprudence had broader discretionary rules for procedure and remedy and could be invoked for the protection of a right or for the redress or prevention of a wrong in circumstances where ordinary legal remedies (such as money damages) did not afford adequate relief. Equity jurisprudence was especially well suited to water rights conflicts because: (1) an ongoing relationship among the parties was implied, so compensation of damages could be seen as an inadequate remedy; and (2) it permitted the parties and the court to search beyond prevailing rules of law for a solution that would effect justice among the parties, even if that meant devising a new set of rules.

Equity jurisprudence was transported to the United States from England, where it had emerged as the body of law developed in a separate set of courts. Although separate equity courts were not maintained for long in the U.S., the capabilities to fashion equitable remedies were widely regarded as belonging to any court of general jurisdiction. In Ex parte Peterson, 253 U.S. 300 (1920), for instance, the U.S. Supreme Court stated: "Courts have, in the absence of prohibition, inherent power to provide themselves with the instruments required for the performance of their duties" which included the authority to appoint fact-finding referees, to issue injunctions to the parties in a case, require discovery of information and documents, etc.

Courts' use of these powers in water resources disputes has enabled water users and other interested parties to develop information about basin conditions, negotiate rules

allocating resource use,¹ appointing watermaster entities to monitor users' compliance with those rules, and compel fair sharing of the administrative costs of basin management. This role of courts as institutions through which individuals and organizations can craft authoritative rules—through which, in other words, they might even craft constitutions—differs substantially from a view of litigation as zero-sum combat or of judges as awarding a victory to one side and a loss to the other. In the words of Judge Leon Yankwich, who presided over the water resources case *United States v. Fallbrook Public Utilities District*, 109 F.Supp. 28 (1952): “It is the aim of litigation to achieve social peace.” (1958: 478) The exercise of equity jurisprudence is one of the means by which that aim is achieved.

The Raymond Basin Constitution. The Raymond Basin case City of Pasadena v. City of Alhambra et al., employed a common equity procedure, reference of factual matters to a

¹ Judge Leon Yankwich (Chief Judge of the United States District Court for the Southern District of California) presided over United States v. Fallbrook Public Utilities District, 109 F.Supp. 28 (1952). That case, an action to quiet title to water use rights in the Santa Margarita River, involved 6,000 defendants. Clearly the information and negotiation task that lay ahead was daunting. Eight of the largest defendants participated in extensive pre-trial discovery actions, and the judge convened them as well as some other parties to try to resolve a number of questions of fact. Afterward Judge Yankwich wrote a law review article, “Crystallization of Issues by Pretrial: A Judge’s View.” He recalled, “After motions to dismiss were denied and a motion for separate trial as to two of the principal defendants and the States of California, which had intervened, was granted, I held a pretrial conference which extended over four days and resolved a good many matters” (Yankwich 1958: 472). Another commentator (Carter 1959: 409-410) recalled in greater detail the strategy the judge employed to drive the fact-finding process forward in that case. The pretrial conference yielded a stipulation of facts concerning the description of the Santa Margarita River watershed, and memoranda formulated and filed by the court governing several of the legal issues for trial. The obvious problem that remained was how to make procedures and agreements that had involved only a small number of the parties applicable to the thousands of others. The stipulating parties and the judge made the agreed facts the “default conditions” that would prevail unless one or more of the other parties could dislodge them. The United States filed an amended complaint on all parties, attached to which was a copy of the pretrial stipulation of undisputed facts as agreed to by the major defendants, and a note that an engineer familiar with the watershed would be prepared to testify and/or submit to cross-examination on the alleged undisputed facts. Any party could cross-examine or present evidence to contradict the alleged facts, but in the absence thereof the court would find the facts to be as stipulated (Carter 1959: 410).

court-appointed referee or special master. With the consent of the parties, the judge appointed the California Division of Water Resources to report on basin conditions, the parties' histories of pumping from the basin, and other pertinent facts. The draft report stated that the safe yield for Raymond Basin as a whole was 21,900 acre-feet per year, but that actual withdrawals and claimed rights totaled 29,400 acre-feet, for a total overdraft of about 8,500 acre-feet per year. To remedy the situation, the draft report recommended limiting withdrawals to the 21,900 acre-foot safe yield and using imported water to meet demands beyond the safe yield.

As the referee's draft report circulated among the parties, most of them agreed to attempt to work out a settlement. Before litigation, failure to negotiate a settlement simply continued the status quo -- the pumping race. With litigation under way, if the parties failed to achieve a negotiated settlement, the court might adopt the referee's report and recommendation or fashion some other remedy. For several parties, the range of possible outcomes extended from a complete loss of rights to a complete protection of rights. Most parties agreed to appoint a committee of seven attorneys and engineers to work out a stipulated agreement that could be presented to the court. It was completed early in 1943. After studying it, Pasadena and all but two other parties agreed to the stipulation, which they presented to the court in November 1943.

The stipulation provided (1) an admission by each of the parties that its taking of water from the basin had been continuous, uninterrupted, open, notorious, and under claim of right, and adverse to the claims of all others, and thus satisfied the requirements of a superior prescriptive right for each party as against all others; (2) an allocation of the basin's safe yield among the parties; (3) the declaration and protection of each party's

right to its specific proportion of the basin safe yield; and (4) an arrangement for the exchange of pumping rights among the parties. The judge signed an order requiring the parties to the stipulation to abide by its terms during the pendency of the litigation, and another order appointing the Division of Water Resources to serve as monitor, or watermaster, for the stipulation. After more negotiation, a brief trial was held in mid-1944. At the end of 1944, the judge signed the judgment in the Raymond Basin case, adopting the stipulation worked out by the parties, limiting each party to pumping rights that together equaled the basin's safe yield and appointing the Division of Water Resources permanently as the watermaster for the basin to report annually to the court on basin conditions and parties' compliance with the judgment. The California Supreme Court later upheld the judgment on appeal.

The stipulation and judgment in Pasadena v. Alhambra completed a first phase of institution building in Raymond Basin. Although it certainly never would appear in the Census Bureau's Census of Governments, water users had constituted a governance structure for the basin through the adjudication process. They had established: their rights and duties in the basin, a monitor to observe and report upon their compliance with those duties, means of checking each other's behavior through the publication and circulation of the watermaster's annual reports, means of sanctioning each other's behavior for violations of the court's injunctions, a representative body of water users, a mechanism for financing the governance system, and, through the court's continuing jurisdiction, an institutionalized procedure for altering the governance system in response to changed conditions, new ideas, or dissatisfaction with its performance.

The Raymond Basin approach has had its detractors. There were criticisms of the expensive and time-consuming court reference procedure. (e.g., Krieger 1955: 910; Goodcell 1961: 3) In addition, the approach was criticized for introducing further uncertainty into California's law of water rights. Efforts to apply the Raymond Basin approach as an institutional formula largely succeeded in the Central and West basins, but failed in the San Fernando and Mojave basins (Blomquist 1992).

Amending the Raymond Basin Constitution. On certain occasions, Raymond Basin users have modified the judgment to alter the management program or to reconstitute the basin governance system. The first modification, based on observed changes in basin conditions, was to the safe yield determination. Underground water levels throughout Raymond Basin rose through 1950 and held steady through 1955, despite ten years of drought and increased total water use. Late in 1950, Pasadena returned to court filed a motion for a review of the original judgment's safe yield determination. The court granted the motion and appointed the Division of Water Resources to make the review. The Division filed its report in October 1954, containing a revision of the safe yield estimate to nearly 31,000 acre-feet, and recommending (after a small allowance for non-parties) that the decreed rights of the parties be increased to 30,622 acre-feet. The court issued a Modification of Judgment on April 29, 1955, increasing the decreed rights of the parties proportionately to a total of 30,622 acre-feet.

A second major modification involved basin replenishment. The original judgment made no provision for artificial replenishment of the basin with conserved or imported water supplies. However, the Los Angeles County Department of Public Works

(formerly the Flood Control District) operates water spreading grounds on each of the surface streams in Raymond Basin -- the Arroyo Seco, the Eaton Wash, and Santa Anita Creek. In addition to these county operations, several Raymond Basin parties conduct water spreading operations -- the Kinneloa Irrigation District, the Las Flores Water Company, the Lincoln Avenue Water Company, the Rubio Canyon Land and Water Association, and the cities of Pasadena and Sierra Madre. Actions taken by these parties benefit all Raymond Basin water producers. In order to maintain an incentive for these parties to engage in spreading, parties modified the Raymond Basin Judgment in 1974 to allow pumping credits for spreading. Under the modification, the Watermaster determines each year the amount of water diverted for spreading, and the county Department of Public Works provides a statement of the amounts actually spread. Each party engaged in spreading is allowed in the following year to extract up to 80 percent of the amount credited to it, in addition to the its decreed right under the judgment.

In 1984, a third major modification to the Raymond Basin judgment reconstituted the basin governance system. Around the time of the 1974 Modification of Judgment, water users in the neighboring Main San Gabriel and Chino basins were developing a new form of watermaster organization. Instead of relying on the state Department of Water Resources as Watermaster, users in these basins selected multi-member watermasters composed of water users or their representatives, and dedicated to a more active approach to managing basin water conditions. After several years of consideration, the parties to the Raymond Basin judgment decided to change the basin governance structure. They returned to court and obtained a Modification of Judgment on March 16, 1984, replacing

the Department of Water Resources as Watermaster with the Raymond Basin Management Board, successor to the Raymond Basin Advisory Board.

The 10-member Management Board, made up of Raymond Basin water users, operates generally by consensus, with the continuing jurisdiction of the court available for decisions in the event of future controversies. The board uses the offices of the Foothill Municipal Water District in La Canada-Flintridge for meetings and as a mailing address, and the General Manager of the District serves as the Assistant Secretary-Treasurer for the board and provides ongoing staff support. These arrangements economize on administrative costs of the board's Watermaster functions.

Although the California Department of Water Resources is no longer the Raymond Basin Watermaster, the Raymond Basin Management Board has retained the services of the Department under contract for preparation of the annual report and for other support services as required. Under this arrangement, the state of California no longer subsidizes the cost of the Watermaster service. The parties to the Raymond Basin judgment pay all costs of the Watermaster service.

Beyond Raymond Basin. The Raymond Basin case is but one example of the crafting of institutional arrangements by water users in California. Since then, through court judgments and the creation of additional public and private organizations, water users have apportioned rights to the flows of a number of rivers and streams in the state (e.g., the San Gabriel, Santa Ana, Santa Margarita, and Carmel rivers) and developed groundwater basin management and governance arrangements (e.g., the West, Central, Main San Gabriel, San Fernando, Mojave River Valley, Warren Valley, Puente, and

Seaside basins). The Antelope Valley and Santa Maria Valley groundwater basins are currently in the midst of institutional creation processes.

The arrangements that have been developed in these locations over the past sixty years vary considerably. The actions in the San Gabriel and Santa Ana River watersheds, and especially the Coastal Plain basins in Los Angeles and Orange counties, indicate that even in physically similar, neighboring basins facing similar threats over the same period, individuals can develop substantially different yet workable responses. Drawing upon the influences of Vincent Ostrom's work, let us consider some of the factors that contributed to successful institutional design and creation.

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Institutions as Human Artifacts

Intentionality and Problem Solving. Understanding institutional development and change entails thinking about institutional arrangements as the deliberate creations of human beings oriented toward some purpose or purposes and operating at multiple levels of action. Human beings are conceived here as acting intentionally to try to solve problems. Social scientists must develop an understanding of the intentions of actors, and in so doing must find ways to take into account actors' statements of their intentions without being taken in by them. Human subjects are not just engaged in social behavior. They are engaged in self-conscious social behavior. Human beings, except when engaged in reflexive or purely habitual behavior, tend to be engaged simultaneously in acting, analyzing their actions, and trying to explain their actions. This is especially the case when people are engaged in more challenging endeavors that require interpersonal communication and coordination.

The southern California cases provide examples of individuals who worked for years (sometimes decades) to develop and implement basin governance structures and management systems. These individuals frequently and repeatedly attempted to articulate what they were trying to do, how successful their efforts were, what impeded their progress, and when they erred. The attorneys who worked in several of the cases -- such as Kenneth Wright, James Krieger, Arthur Littleworth, Donald Stark, and Susan Trager -- have written descriptions and evaluations of the arrangements worked out in the basins. Likewise, engineers and geologists such as Harvey Banks, Max Bookman, John Mann, and Thomas Stetson, have contributed several addresses and writings reflecting on the governance and management systems, the reasoning behind them, and how they have performed. Association members, board members, district managers, and other participants -- such as Carl Fossette, Ben Haggott, Alfred Jorgensen, Mel Blevins, and Duncan Blackburn -- have written, testified, spoken at conferences, etc., about their experiences, accomplishments, and frustrations in devising the institutional arrangements in the cases presented here. What is common to, and on display in, all of these commentaries is the intentions of the actors to come to grips with situations that they perceived to be problematic, to explore possible solutions using available institutional tools, and to invent new tools in some instances where needed or desired.

Communication and Deliberation. In settings such as these, human beings are engaged in collective problem solving. Interaction between individuals in such circumstances can be constructive ("two heads are better than one") or confounding ("too many cooks spoil the

broth"). In any given collective problem-solving situation, a considerable proportion of the process will be devoted to reconciling alternatives or choosing among them.

Communication therefore becomes essential for disseminating information and signaling intentions in collective problem-solving situations. Yet, communication also is a source of difficulties: it cannot be assumed that communication is immediate, perfect, and without cost. In the water resource arena, empirical observation has established that the "first response in most areas to some type of water problem is the creation of a water association to provide a forum for discussion" (Coe 1986: 15).

An Institutionally-Rich Environment. Institutional arrangements developed and experiences accrued in the course of collective action are important components of a community's social capital. When first confronted with a change in their conditions and circumstances, or with an incompletely understood problem, individuals can be expected to engage in limited search of the environment (including the recent past as well as similar or familiar situations in the present). In so doing, they draw upon previously created instruments and procedures for the gathering, classifying and storing, disseminating and retrieving, and pooling information. The information developed about their own problem, and any innovation in the means by which they acquired it, then constitute additions to the set of instruments and procedures for gathering, classifying and storing, and disseminating and retrieving, information.

As their understanding of the problem they confront improves, individuals may attempt to design new institutional arrangements for ordering their relations with each

other and responding to the problem as they understand it, or they may adapt existing institutional arrangements in light of the revised understanding of the problem.

Frequently, they do some of both. In devising and adapting institutional arrangements for response to the problem, individuals again draw upon existing institutional arrangements for assistance, for ideas about what to do or what to avoid. This may range from copying an existing institutional arrangement (such as a contract) essentially unchanged to using existing institutional arrangements (such as legislative or judicial procedures) to creating new arrangements suited to the particular circumstances as they are understood by the individuals involved. The institutional arrangements designed at this stage, as well as the experiences gained in adapting existing institutional arrangements to a different set of circumstances, become additions to the stock of social capital.

With this conception of institutional arrangements as a form of social capital that individuals draw upon and add to as they engage in problem solving, the idea of "an institutionally-rich environment" acquires real significance. Individuals in an institutionally-rich environment -- where considerable investments have been made in diverse institutional arrangements for learning about and responding to problems -- are likely to have real advantages in understanding and responding to collective problems (Nunn 1986). In an institutionally rich environment, individuals with limited information-processing and communication capabilities coping with a changeable world should be able to perceive and employ more ways of acquiring needed information, more means of sharing costs and distributing benefits, and more possibilities for overcoming problems.

In California during the 20th century, water users operated within an institutionally rich environment. One crucial component of that environment was the availability of courts with equity powers, which has already been noted above. Another was California's tradition of "home rule," of letting individuals and organizations craft solutions to local problems rather than attempting to develop uniform statewide responses directed from Sacramento. Related to this was a third component, the menu of special-purpose government agencies that had been established by the California Legislature through enabling legislation—templates existed for the establishment of irrigation districts, municipal water districts, and later, county water districts, which water users and their representatives drew upon frequently to establish public organizations to undertake management endeavors. From this enabling environment, water users crafted new types of governmental organizations to encompass groundwater basins and watersheds, and nongovernmental water associations that crossed jurisdictional boundaries and encompassed numerous organizations as members.

Enumerating the membership of the West Basin Water Association and the Central Basin Water Association, Carl Fossette placed their combined membership at "105 member agencies, including representatives from 27 cities, 9 public water districts, 24 water companies, and 45 industries." (1961: 91) Existing organizations—and the experience of individuals within them—became the building blocks of new organizations. Water users adapted existing practices and institutional arrangements to their needs, as well as developing new arrangements tailored to their circumstances.

Problem-Solving as an Evolutionary Process. Many questions are embedded in any problem-solving process: what do we know, what do we need to learn, how can we find out, how do we communicate, how do we decide, who goes first, how do we make assurances with each other, how do we check each other, and so forth. Human beings may cope by exploring alternatives and taking actions cautiously and incrementally, adding experience to their information base as they proceed. Ideas are confronted with experience. How one's actions affected and were affected by the characteristics of the physical world can be reviewed to see if the outcomes were desirable, and to revise estimates of the physical world. Expectations about others' behavior are confirmed and reinforced, or contradicted and revised. Feedback is obtained from experience and experimentation, through a process that is not "mere" trial and error, but "trial-and-error learning" (Ostrom 1990: 34). People "do what they have learned and then learn what they have done" (Lindblom 1990: 221).

These means of coping with the uncertainties involved in collective problem solving, through the sequential development of institutional arrangements, suggest a path-dependence to institutional development analogous to evolutionary processes (E. Ostrom 1992). Careful consideration of context becomes especially important, as it is vital to know where action is occurring in terms of process as well as time and place. Abstractions from context can lead to faulty analysis, because differences in context are likely to influence the institutional arrangements established by people engaged in problem-solving processes.

An evolutionary perspective on problem-solving and institutional development implies neither teleological explanations of what has occurred to date nor predictions of

convergence to a single form. Notions of intentional problem-solving, experimentation, and learning from search and experience leave prospects for creativity, as well as gradual learning through the accumulation of experience and the continual limited search of the environment. Conceived as an evolutionary process of deliberate choice within constraints, institutional development follows the normal course of economic and political life, in which some behavior is adaptation and "muddling through," but also in which intentional efforts at problem-solving, building on experience and coping with uncertainty and constraints, produce new methods and designs. This appears to be an accurate characterization of what has occurred in several parts of California with respect to the crafting of water institutions.

Self-Interest Rightly Understood. Certain beneficial political effects of the water management systems in California are important to consider. These decision-making processes have required water users to take into account, and attempt to accommodate, one another's interests in order to reach any desired outcome. Water users in the San Gabriel River watershed frequently disagreed during the decades they spent constructing the governance and management systems there. Along the way, they developed a norm of "not walking away from the table" (Fossette 1986).

The decision-making processes and polycentric governance structures employed by the water users called on many individuals to play multiple roles over time, which required them to take each other's interests into account. At various times, an engineer might offer consulting services to a water user, represent that water user in negotiations, testify as an expert witness, serve as a district manager or board member or watermaster,

and lobby the California legislature on a particular issue on behalf of all southern California water producers. Similarly, local attorneys at time represented water users and districts and also lobbied the legislature, city mayors and utility directors also served as officers of water users' associations, and so forth. Most of the actively involved individuals at one time or another shifted from consultant to advocate, from advocate to manager or board member, and from principal to agent.

Their multiple links and multiple roles contributed to the participants' understanding of one another's circumstances and of the importance of cooperation and coordination. In this way, the participants heightened what Tocqueville called the sense of "self-interest rightly understood," that is, self-interest that is informed and qualified by recognizing the need to take the interests of others into account. The many roles played by so many of the participants in these cases had beneficial political effects similar to those Tocqueville observed about the jury system, which places ordinary citizens temporarily in the position of magistrate, requires them to learn something about the law, and obliges them to cooperate with a group of their fellow citizens in reaching a decision requiring consensus. In *Democracy in America*, Tocqueville described the jury system, participation in associations, and involvement in local government as three "free schools" in which Americans learn the behavioral and attitudinal prerequisites of a self-governing democracy. Since the water users in the successful cases presented here spent most of their careers participating in associations and local government, it is not surprising that they developed the skills of which Tocqueville wrote.

Learning and Entrepreneurship. It is no small accomplishment to craft a polycentric, self-governing system that is well-tailored to problems, takes advantage of specialization and scale, improves the information base for collective decision making, and attains high levels of cooperation and compliance. Such an effort requires individuals to apply skills and knowledge that are not "given" to individuals at the outset of a collective problem-solving process. In Vincent Ostrom's (1991: 243) words, "We can rule out the possibility that a polycentric system of order... will emerge spontaneously. Instead, it is necessary, as Tocqueville suggested, to draw upon a science and art of association in learning how to put polycentric systems of order together."

Entrepreneurship is a vital aspect of collective problem-solving, directed toward achieving complementary combinations of heterogeneous elements of physical, financial, human and social capital, and moving across levels of action. Ideas are not automatically transformed into working innovations, heterogeneous elements of various forms of capital cannot be combined in just any fashion, and not just any outcome will do. Entrepreneurship involves the development over time of skills in collective problem solving, based on experience in particular situations where time and place specificities apply (Hayek 1945; Lachmann 1978; Elster 1983).

In overcoming some of the difficulties of collective problem-solving situations, a key problem is one of organizing (Ostrom 1990: 39). Individuals who develop entrepreneurial skills learn what institutional resources can be drawn upon in gathering information, developing means of communication, taking and implementing collective decisions, and crafting institutional arrangements to ensure the coordination of expectations and sustainability (see Elster 1983: 78-79). Accordingly, individuals who

have developed entrepreneurial skills gain capabilities for diagnosing situations and determining when existing institutional arrangements cannot be adapted to address a particular problem and new ones will have to be crafted

The local engineers, public officials, businesspeople, attorneys, and farmers who designed and developed institutional arrangements in southern California succeeded to the extent they have partly because of the advantages of polycentric, self-governing systems in an institutionally-rich environment. They also succeeded because they developed the skills to capitalize on those advantages. The most vulnerable aspect of polycentric, self-governing systems is the ability of people to craft and maintain them in order to capitalize on the advantages they offer. People can only develop the kinds of institutions that will resolve problems and improve conditions if they know what they are doing.

Knowledge of hydrology and engineering can be communicated to and considered by local water users more readily than the detailed knowledge of local physical, economic, political and other conditions can be communicated to and considered by central decision-makers (Hayek 1945). Local water users have more information about the particular characteristics of the resource and of the community or communities dependent on it (Uphoff 1986: 36), and this "knowledge of the particular circumstances of time and place" turns out to be of greatest importance in governing a basin or watershed. The California cases show that expertise and wisdom are not the sole province of central public authority, that innovation in groundwater management is not limited to the public sector nor efficiency to the private sector, that diversity in governance and management

systems is not a sign of disorderliness or impending disaster, and that citizens have considerable ability to self-organize and solve complex problems.

* * *

Fallible Beings and Flawed Artifacts

On the other hand... there are a number of locations (in California and elsewhere in the world) where water problems worsen and suitable institutions remain wanting. The success of some cases, problems of others, and failures in many underscore that institutional development is a human enterprise and thus subject to significant limits.

Bounds on Problem Solving Capacity. Viewing human activity as intentional problem-solving refers only to the purpose of behavior, not the outcome. It does not mean that people solve problems automatically, consistently, or optimally. While human beings engaged in processes of institutional development are conceived as purposeful and self-interested, and intelligent and capable of learning, they are also constrained by limits on their capabilities and limits imposed by the physical world, and are therefore prone to error. The institutional arrangements they create in attempting to solve collective problems have intended and unintended consequences, and often fall short of "optimality" when measured against models in which constraints have been removed or assumed away (Ostrom 1990: 14).

People make their institutions, but they do not make them just as they please. Some constraints are imposed by the physical world. The physical world exhibits limits that individuals apparently cannot change even if they wish, and even if they try (gravity, mortality, and so on). Other aspects of the physical world are subject to change without

warning, and without regard to whether the changes are desired by human beings or compatible with their plans (weather, natural disasters, and the like). Human problem-solving involves navigating within a physical world that offers opportunities, obstacles, and uncertainties.

Other constraints are limits on the capabilities of human beings. On the whole, people are neither as smart as they think they are nor as dumb as they sometimes look. The human organism is "a choosing, decision-making, problem-solving organism that can do only one or a few things at a time, and that can attend to only a small part of the information recorded in its memory and presented by the environment" (March and Simon, 1958: 11). There is what Ronald Heiner (1983) has called a "gap" and what Charles Lindblom (1990) has called a "tragic discrepancy" between the competence of human beings and the difficulty and complexity of the tasks we face. People never have all of the information they need, and yet they are unable to process all of the information they have. They are capable of understanding, and of misunderstanding, themselves, each other, and the physical world.

This "bounded rationality" approach differs in important ways from others employed in analyzing collective problem-solving situations, especially the neoclassical view of "economic man." Among the key points of Hayek's critique of that view was that its assumption of identical, fully informed, flawlessly calculating individuals collapsed the task of modelling collective problem solving into the modelling of individual problem solving. He argued that this could not be done effectively. Not only does all of the information needed to solve collective problems not exist in a single mind, it cannot be given to a single mind (Hayek, 1945).

Other analysts have added that these shortcomings are not redressed by plugging "costly information" or positive transaction costs into the modeling of situations still animated by economic man. Nelson and Winter (1982: 66) point out that costly information makes only a quantitative rather than a qualitative difference if individuals still are viewed as "perfect mathematicians" with unlimited information-processing capabilities. Such individuals still could make unerring investments in acquiring additional information, then reduce all uncertainties to maximum likelihood estimates, and proceed on the basis of their common best estimate to define and implement optimal strategies. Again, collective problem solving reduces to individual problem solving.

The concept of transaction costs, vital to understanding social behavior and the emergence of nonmarket institutional arrangements such as the firm, nevertheless does not provide an adequate understanding of institutional development if it remains coupled to the conception of economic man. As the literature reviewed and summarized by Eggertsson (1990: 102n) points out, the actions of economic man are always efficient, even with the presence of positive transaction costs. If institutional arrangements are developed and sustained, their benefits exceeded the costs; if not, the costs exceeded the benefits. Of this sort of analysis, Field (1979: 57) stated succinctly, "In accounting for both, it explains neither." (see also Bromley, 1989: 5)

To examine institutional development with a conception of human action as boundedly rational problem solving brings into focus additional difficulties, as well as opportunities. Boundedly rational individuals do not optimize in the general sense of surveying all possible alternatives and anticipated consequences and then selecting the best option (Alchian, 1950: 211; Eggertsson, 1990: 77). This does not mean that we must

drop the assumptions that individuals are rational and self-interested; we still can assume that people are rational in Popper's sense of "acting in accordance with the situation" and self-interested enough to choose their best option if they know the alternatives and their consequences. Rather, we need to recognize that the best option is generally not known in advance, nor is the situation fully understood, and individuals usually have to expend effort in finding out what it is. (Lachmann, 1978: 3)

There are two hindrances here for boundedly rational individuals. The first is not knowing in advance the desired outcome or solution. As jazz artist Humphrey Lyttelton, who reportedly said, "If I knew where jazz was going, I'd be there already." (Elster, 1983: 9) The second hindrance is not knowing what actions will lead to the desired state of affairs even if it were foreknown. Armen Alchian (1950: 218n) offers a different analogy: "The situation is parallel to trying to control the speed of a car by simply setting by hand the indicator on the speedometer." Instead, the challenge of learning to drive a car is to operate its various components so as to reach and maintain the desired speed.

As several analysts have described, boundedly rational individuals attempt to overcome these hindrances created by lack of knowledge of their situations, options, and likely consequences by searching for additional information. Because their information-gathering and information-processing capabilities are limited, individuals typically engage in limited searches (see, for example, March and Simon, 1958: 140; Nelson, 1987: 21; Lindblom, 1990: 7; Ostrom, 1990: 209).

Although limited, search activity in effective problem-solving is not blind (March and Simon, 1958: 140). Search activity tends to focus on other situations or experiences that appear nearby in place or time. Similar-looking problems experienced in the recent past

by oneself or by neighbors are likely to shape the understanding an individual has of a situation and to bias the selection of alternatives for action. Actions that seem to have been successful in the past or for someone else are likely to be copied in the hope they will yield success again (Alchian, 1950: 218).

Limited search is quite rational, but still can result in decisions being taken on faulty premises, and individuals still will be prone to error. Seizing upon the similarities between two situations, individuals may overlook a crucial difference that causes a successful strategy in one to yield failure in the other. Actions taken at one time may be attempted again at another but executed differently, and the difference in execution may produce a different outcome. Out of these variations come frustration, failure, surprise, improvement, success, confusion... in varying degrees and combinations. These outcomes were certainly realized by those in the San Fernando and Mojave River cases who tried to apply a formula from the neighboring basins.

Coping with Others in the Commons. Uncertainty is significantly greater in collective problem-solving situations if the problems are not fully understood, if individuals' perceptions of the problems and which actions to pursue differ, and if communication is problematic -- all of which are reasonable expectations. The actions of individuals attempting to solve problems will obviously be shaped by their understanding of their situation. Full knowledge of their situation is not "given" to them. The institutional arrangements devised by water users at different times reflected their changing understandings of their situations, and the learning they acquired along the way.

At this point, participants in an interdependent situation may also be expected to become concerned about the unpredictability of other participants' actions. The fact that human behavior is indeterminate presents as great a problem for human beings dealing with each other as for analysts. In order to make plans and choices, actors need to reduce indeterminacy (including the gap between stated intentions and actual behavior) to a manageable level.

Several analysts have proposed that it is precisely this indeterminacy that encourages people to develop and rely upon norms and rules for ordering their behavior and making their actions predictable. Heiner (1983) identifies "the origin of predictable behavior" in the effort to deal with uncertainty and unpredictability. Alchian (1950) suggested that boundedly rational individuals may be more likely to cope with uncertainty by adopting relatively persistent "modes of behavior" in dealing with a certain problematic situation rather than making continuous marginal adjustments in each period based on some optimization criterion. March and Simon (1958: 4) point to the functional utility of organizational "roles" for enhancing predictability in an interactive environment: "Not only is the role defined for the individual who occupies it, but it is known in considerable detail to others in the organization who have occasion to deal with him." Runge (1984: 155) emphasizes the incentive of individuals who might reap advantages from collective action to establish institutional arrangements to coordinate their expectations about each others' behavior. Over time, uncertainty is reduced as institutions coordinate expectations and their operational qualities become known (Eggertsson, 1990: 72).

Failures and Mistakes in the California Cases. Even skillful and experienced entrepreneurship is practiced by fallible beings operating under constraints. In the development of the governance and management systems in California, tactical mistakes were been made and design flaws can be found. Improvements could be made, even in the most successful cases (see also Lipson 1978: 21).

Analysts who have written about the "mutual prescription" doctrine devised during the Raymond Basin adjudication have noted the race to the pumphouse it engendered. This was an unintended but not unforeseeable consequence of basing the size of pumpers' rights on recent historical use. Since the "mutual prescription" doctrine would apply only in an overdrawn basin, and overdraft would imply reductions in groundwater use, the clear incentive for pumpers after *Pasadena v. Alhambra* was to escalate their groundwater extractions in anticipation of an adjudication, so that the consequent reduction would still leave one with a "liveable" pumping right.

The success of the West and Central Basin adjudications spawned two of the greatest tactical mistakes in development of groundwater basin management in southern California. The judge in the Central Basin case moved over to the *Los Angeles vs. San Fernando* litigation and issued a judgment imposing a mutual-prescription division of the waters of the San Fernando Valley over the objections of Los Angeles and in contradiction to a long series of cases. This ultimately led to reversal in the California Supreme Court. That 1975 Supreme Court decision left considerable uncertainty over the status of mutual prescription (and basin adjudications generally), helped to finish off the faltering adjudication that had started in the Mojave River Basin, and produced the much

more complicated groundwater management arrangements in Chino Basin that leave some overlying users without firm, tradeable rights.

During the same period, some of the attorneys and engineers involved in the Central Basin adjudication moved north to the Main San Gabriel Basin and the Mojave River Basin. In the Main San Gabriel Basin, the Central Basin "formula" was adopted, with important modifications. The Mojave River Basin presented a different set of circumstances however, and the mutual-prescription solution was strongly and successfully resisted by smaller overlying landowners. They did not perceive it as a formula for resolving groundwater problems, but as a water grab by larger upstream ranchers and appropriators. The collapse of the Mojave River adjudication was accompanied by the collapse of the proadjudication majority on the Mojave Water Agency Board of Directors, and the dismissal of pro-adjudication staff members (the agency manager, engineer, and attorneys).

The collapse of the Mojave River adjudication in the 1970s represented not only an attempt to impose a formula, but to move much too quickly in doing so. In previous basin adjudications based on mutual prescription, general agreement first existed about the general shape and nature of the water resource. In the Mojave River adjudication, differences persisted up to the time of the dismissal of the lawsuit over whether the water resource consisted of a single area of influence, an underground stream subject to the laws governing surface watercourses, or a series of three distinct underground basins. It is impossible to say whether water users could have reached a common understanding about the resource, and beyond that whether they could have reached agreement on a plan for allocating rights to its use. Nevertheless, moving forward with an adjudication when

users do not even agree about the basic nature of the resource was a significant tactical mistake.

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Concluding Comments

The California experience suggests that all of these possibilities and outcomes of institutional development are best understood in terms of deliberate problem-solving action by fallible beings operating within constraints. The institutional arrangements for governing groundwater in southern California are polycentric, self-governing systems. The basin governance systems are nested within watershed governance systems and integrated with other governance systems—counties, MWD, the State of California, regional water quality boards, etc.

Nevertheless, groundwater use and the allocation of water between basins are governed by rules that were fashioned primarily by the water users and their representatives. Water users participate in the selection of members of boards that constitute, govern, or check watermasters or water districts that promulgate rules and regulations governing the behavior of the water users. Most of these water users are also members of associations that discuss basin conditions and management options. Several of the associational memberships overlap; there is a network of water associations.

Most of these management programs have been perceived as legitimate and fair because they are decided upon through basin governance structures designed by, and participated in by, the water users themselves. In the successfully-managed California basins, water users have participated in designing the processes for making the rules, making decisions within the rules, and designing the processes for enforcing the rules.

These sorts of reciprocal rule-ruler-ruled relationships (V. Ostrom 1991) are more likely to be sustainable and to gain compliance than systems based on a sovereign authority and a separation between the rule-maker and the ruled.

The sustainability of the basin governance and management systems in southern California is tied as much to the fact that local users designed them as it is to the particular designs they arrived at and adopted. After comparing the basin management systems in West Basin and Orange County, Charles Corker observed that the "important fact appears to be that there was a choice, and each district chose -- or perhaps it would be more accurate to say discovered -- a pattern which proved to be workable and acceptable" (quoted in Schneider 1977: 49).

This does not mean that water users made no mistakes or compromises in devising these systems, or that there is no "fragmentation" or "duplication" anywhere in southern California water supply management. The basin governance and management arrangements that have been developed are not perfect. They were not arrived at flawlessly. Mistakes were made along the way. Design flaws remain that could be remedied, and there are a few tendencies in the operation of the institutional arrangements that give reason for concern.

These errors and design flaws are more than offset by the effectiveness of the polycentric arrangements in overcoming serious problems of groundwater depletion, halting salt-water intrusion along the coast, and resolving upstream-downstream conflicts. The water users prefer these arrangements, not because they harbor some perverse preference for uncoordinated and ineffective management, but because the diverse systems they designed work reasonably well, and because they would rather

govern their basins and watersheds themselves than have someone else do it for them or tell them what to do. As many of us learned from the work of Vincent Ostrom, despite their limitations human beings possess capabilities for self-governance, the ability to reason and deliberate together, and solve problems. The water constitutions of California, though they are flawed artifacts of fallible artisans, are a testament to that insight.

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