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**Deliberation, Learning, and Institutional Change:
The Use of Judicial Forums in Institutionally Diverse Settings**

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We live in an uncertain and ever changing world that is continually evolving in new and novel ways. Standard theories are of little help in this context. Attempting to understand economic, political, and social change (and one cannot grasp change in only one without the others) requires a fundamental recasting of the way we think... . If we can achieve an understanding of the underlying process of change, then we can develop somewhat more limited hypotheses about change that can enormously improve the usefulness of social science theory in confronting human problems.

(North, 2005: vii)

The Challenge of Changing Institutions

Most of modern human life is spent within the structure of diverse institutional arrangements. We learn the “proper” rules of interactions with family members and friends as we are raised. Schools not only teach us history, mathematics, and grammar, they also provide instructions about many of the existing institutional structures that affect our lives. What must we do to complete a school year? What must we do if we are to graduate from high school? What must we do to get a drivers license? What must we do to gain admission to college? Learning the “rules of the game” is a major pre-occupation of all humans especially in their youth.

Rules are, however, human inventions. Consequently, humans not only learn how to act *within* a set of established rules, but they also are engaged from time to time in changing rules within a nested set of other institutions that structure the process of changing rules at any particular level. Changing rules is, however, far more challenging than simply trying to do as

well as one can within an established set of rules. Whenever one is engaged in thinking about changing rules, one has to begin to look farther into the future than daily life and imagine the likely strategies that relevant others and one's self will adopt to one set of possible rules versus other potential sets. In his analysis of *The Moral Judgment of the Child*, Piaget (1932) studied the stages of learning involved as children learned to play self-organized games of marbles on a school yard. Piaget analyzed the cumulative difficulty involved in learning to play this game. The most difficult task was learning how to propose rules that would improve one's chances of doing better. Changing rules – even for the childhood game of marbles – was seen by Piaget as involving the highest level of intelligence as compared to the substantial physical and strategic skills acquired in playing the game within a set of established rules.

When interacting within an established set of rules, participants can use the information from past interactions to judge the likely patterns of interactions that will result from continuing their past strategies or changing their own strategies. Even in simple settings with complete information about the present structure and the past sequence of one's own and other's behavior, planning future strategies can be challenging. This is illustrated by the years of effort devoted by many programmers to trying to develop a computer program to play the game of Chess well enough to beat a champion human player.

When proposing a change in rules, an innovator must try to project the likely actions of others affected by the change in rules as well as their own, and how the pattern of interactions at one point of time within the new rules will likely affect future patterns of interactions. While most humans have some experience in crafting rules related to their own family and neighborhood interactions—in other words with people they know well -- they do not have extensive experience in crafting rules affecting a broader set of individuals that they may not

know at all. When the process of crafting rules is related to the use of natural resources that are characterized by complex dynamics that are frequently only imperfectly understood makes the task of institutional change even more difficult. The entrepreneur must try to project how changes in institutions will affect the rights and duties of participants, the patterns of interactions among those affected, how these interactions will affect a resource, and how changes in that resource will in turn affect the perceptions and actions of participants.

The success of any effort to innovate new institutions depends not only on the skills and knowledge of the entrepreneur trying to improve some set of outcomes for self (and potentially for others) but also on the nested institutions that specify the steps that need to be taken to move from an inspiration related to institutional change to a completed change in the rules at a particular level. If the participants are nested in a set of higher rules – a national or regional government, for example – that does not allow the participants to change any of the rules, the participants will have to petition the officials in that broader institution to change the rules for them. Seeking rule changes from higher-level officials may involve rent-seeking activities both on the part of the participants and the officials seeking rewards for their help. If the broader institutions have given all powers to a local group and never conduct any oversight at all, those who have more power locally may use it to make rule changes that advantage only themselves. Thus, it is important to examine not only local conditions stimulating thoughts about changes in rules, but also the broader set of institutions – executives, legislatures, and court systems – that may enhance or detract from the capabilities of local participants crafting better rules over time.

Considerable progress has occurred in our understanding of the likely pattern of outcomes resulting from the use of particular institutional arrangements to structure the

provision, production, and exchange of specific types of goods and services.¹ The more challenging problem of dynamic analysis is now on the agenda of scholars who are associated with the New Institutional Economics (NIE) and the Institutional Analysis and Development (IAD) approaches to the study of institutions and outcomes. In this paper we will examine the potential role of adjudication in a democratic society in facilitating processes of experimentation, deliberation, and learning, and thus contributing to better institutional designs related to complex resource problems.

A recent article by Knight and Johnson (2007) stimulated us to focus on the potential role of courts applying the principles of equity jurisprudence in disputes over rights to the use of common-pool resources and their potential for crafting new institutions. In comparison with some of the “quick fixes” that are imposed on environmental problems that reach crisis proportions (Sterner, Troell et al., 2006), equity courts may be able to facilitate “creative fixes” to the basic rules affecting resource extraction and sustainability. We will focus primarily on the role of courts in creating new institutions for ground water allocation and continued monitoring in Southern California. While we examine the role of courts in helping water users craft more efficient and equitably institutions in Southern California, the question of what kind of collective choice institutions may facilitate effective institutional change at an operational level is relevant to current disputes over water rights in other locations including Australia.

Virtues and Shortcomings of Judicial Decision-Making for Institutional Assessment and Change

¹ See Stake (2005) for a review and synthesis of the long academic debates (for example, Rubin, 1977; Priest, 1977; DeAlessi and Staff, 1991; Hart, 1994; Roe, 1996; Rubin, Curran and Curran, 2001) related to whether evolutionary processes occur within common law procedures that may facilitate the process of litigation in civil law moving toward more efficient outcomes over time. Stake focuses specifically on decisions in property cases – in contrast to torts – because property cases are more likely to return to the courts for reconsideration. “In other words, there is a feedback loop, a mechanism that returns the output of a system back to the system’s input, that provides courts with opportunities to overturn inefficient common law property rules (Stake, 2005: 406).

Recently Knight and Johnson (2007) presented an argument in favor of an experimental-pragmatist approach to the formation and modification of political-economic institutions. In developing that argument, Knight and Johnson write about the challenge of assessing institutional performance. Institutional assessment is, of course, essential to the ability of human beings to sustain and adapt institutions; hence, it may also be a vital component of robustness of institutional arrangements.

Although Knight and Johnson argue in the article for the superiority of “democracy” (by which they mean voting combined with political debate under circumstances of freedom and equality), they provide an extended and thoughtful discussion of courts and judicial decision making as formal institutions through which people also might develop, maintain, assess, and adapt institutional arrangements. Posing the question, “to what extent can courts adequately undertake the tasks of monitoring conditions and assessing consequences in the ongoing process of effective institutional performance?” Knight and Johnson carefully present H.L.A. Hart’s (1994) argument for the desirable qualities of judicial decision making, an argument they characterize as an example of the “most favorable, yet plausible, justification” for the comparability or even superiority of judicial institutions.

Hart’s advocacy for courts rests on a view that the primary mode of judicial decision making is “the application of primary rules to new fact situations.” (Knight and Johnson 2007: 58) The “rules of recognition” embedded in legal institutions require the justification of decisions in terms of predetermined rules to which the litigants as well as the judges may refer. The resulting, and desirable, qualities of judicial decision making are neutrality and consistency, as opposed to the arbitrariness or partiality that would likely result from the imposition of decisions based entirely upon a judge’s own ideology or interests. The tendency toward

neutrality and consistency is supported by limitations on judicial decision making: 1) the reactive nature of courts, which cannot insinuate themselves into controversies unless and until an interested party brings an issue to the courts, and 2) the restrictions on who can count as an interested party (most plainly, rules of legal standing).

Thereafter, Knight and Johnson (2007: 59-60) articulate what they perceive to be a number of shortcomings of judicial processes as means for assessing institutional performance and bringing about institutional change. Knight and Johnson believe these shortcomings at least balance and perhaps more than offset the advantageous properties identified by Hart and others. The same restrictions on judicial discretion and on the definition of interested parties, which Hart argued contribute to the strengths of judicial decision making, are in Knight and Johnson's view detrimental to the suitability of courts as forums for institutional assessment and change.

Specifically, their argument (2007: 59) is as follows:

- Courts are unable to consider effectively the most relevant questions that are involved in institutional performance assessment, namely, “to what extent is the institution satisfying its intended goals?” and “would another institutional form do a more effective job?” Answering these questions entails “basic considerations of institutional goals as well as criteria of effectiveness,” which Knight and Johnson conclude that courts cannot adequately address.
- Courts are unable to take into account “the full array of interests, attachments and commitments in a society by affording them equal opportunity of access to political influence.” Restrictions on who may participate in litigation render “the outcome of assessment processes correspondingly... suspect.”
- Because the rules of recognition in legal institutions constrain legitimate argumentation to “invoking and applying predetermined rules... many issues relevant to the assessment of institutional consequences” will be excluded from consideration, a result that is inconsistent with institutional assessment conceived as consisting of “ongoing processes of experimentation.”
- Courts are limited in the remedies they commonly impose by constitutional and legal rules determined elsewhere in the political system. Typical judicial remedies “consist of sanctions aimed at forcing individuals to comply with the dictates of predetermined rules.” In fulfilling this role, “courts are not reflexive in the sense that questions

regarding the general validity of either institutional forms or procedural constraints remain beyond their purview.”

At the close of their section on judicial decision making, Knight and Johnson conclude

(2007: 60)

Courts are appropriate for resolving particular controversies (including particular violations of institutional conditions), but are inadequate to the task of ultimately assessing the requirements of general institutional performance (the reconsideration of conditions as well as the assessment of institutional outcomes). To the extent that courts might be remodeled to better undertake these more general tasks, they would have to be refashioned to look more like institutions of democratic decision-making.

Supplementing the View of Judicial Decision Making

Knight and Johnson acknowledge that “this characterization of judicial institutions clearly is incomplete. It is sufficient, however, for the purpose of assessing whether courts might effectively monitor institutional performance.” (2007: 58-59) It is possible, and it is our purpose in this paper, to supplement the characterization of judicial institutions provided by Knight and Johnson and thus render it somewhat less incomplete. Specifically, we intend to add elements of the adjudication process that allow for 1) the crafting of new rules in addition to the application of predetermined ones, 2) the adaptive bounding of affected parties in order to define (and occasionally redefine) the relevant community whom rules will affect and who therefore should have a voice in their creation and modification, 3) the roles that participants other than judges play in bringing information about institutional performance to bear upon cases, particularly in institutionally diverse settings, and 4) the availability of procedures that promote reflexive consideration of institutional performance and provide opportunities for institutional change. The questions that will remain after these additions are: (a) whether any empirical examples illustrate and support our claims about these additions, and (b) whether this fuller view of judicial institutions, combined with the empirical illustrations, warrants a focused

reconsideration of the assessment of their capabilities for monitoring institutional performance and facilitating institutional change. Informed use of equity jurisprudence can help citizens who face a complex resource problem to gain accurate information about their setting and enable them to craft rules and modify these rules over time in light of new information.

1. Crafting institutions through adjudication: equitable procedures and remedies, and stipulated judgments.

Knight and Johnson's observations about the restricted capabilities of courts largely overlook the availability of a form of judicial decision making that is based not on criminal nor on civil law, but rather on equity jurisprudence. 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.

Parties initiating a judicial action based on this form of jurisprudence must specify in their initial proceedings that the issue to be decided does not involve a question as to whether some parties have broken civil or criminal law. Rather, the parties must identify a major problem they are facing that requires a court of equity that will determine core information about past actions and results and eventually develop an equitable solution to a difficult problem. Equity courts are not restricted to applying and enforcing rules that were fashioned in other settings. Equity courts can fashion new rules. And, through the use of courts exercising equity jurisprudence, people can in fact fashion diverse institutional arrangements.

Equity jurisprudence had broader discretionary rules for procedure and remedy that can 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) do not afford adequate relief. Equity jurisprudence has been especially well suited to cases involving institutional development and performance, because: (1) an ongoing relationship among the parties was implied, so mere compensation of damages could be seen as an inadequate remedy; and (2) equity 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.

In the words of Judge Leon Yankwich, who presided over *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. This role of courts as institutions through which individuals and organizations can craft authoritative rules differs substantially from a view of litigation as merely the application of predetermined rules to new fact situations.

2. Adaptively defining the array of affected interests: discovery procedures and the addition and deletion of parties.

A major problems facing citizens who use underground sources of resource flows – especially water -- is determining both the boundaries of the resource system and thus who is jointly using that system. This information is crucial for determining who has what rights for future use as a result of their past uses (V. Ostrom, 1962). Joint users of a lake have a relatively easier problem than users of a groundwater basin in designing new rules. The boundaries of the lake itself are relatively easy to establish. Thus, determining who is taking water (or fish) out

and who is putting pollutants into the lake is a relatively low cost discovery process.

Determining the boundaries of a groundwater basin or an oil field, on the other hand, requires substantial investment in scientific inquiry to learn about geologic structure, underground fault lines, and soil types. Key to the successful resolution of disputes over whether Party A is harming Party B is the development of a process of discovery that both Party A and Party B consider to have be based on careful, objective, scientific measurement which is adequately described so that all those potentially affected have an opportunity to understand and potentially challenge the findings (see E. Ostrom, 1965).

In Ex parte Peterson, 253 U.S. 300 (1920), 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 to negotiate rules allocating resource use.² A key aspect of this form of judicial decision-making is the appointment of a

² 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-

neutral but highly qualified person or firm to serve as a Watermaster initially to determine an accurate history of the water withdrawals made by all parties to the suit (which may be a large number) and then to monitor users' compliance with the new rules that are devised. Further the court can compel fair sharing of the administrative costs of determining past history of use, agreed upon water rights, and continued monitoring of water use – all key aspects of basin management even though still further investments in new institutions may be needed to create public jurisdictions with a specific charge of basin management.

3. Learning about performance in institutionally diverse settings: overlapping parties and witnesses.

The ability of a court (or perhaps any other formal institution) to effectively assess institutional performance depends upon the availability of information about comparable cases. Knight and Johnson would be quite correct about the limitations of courts in this respect, if one adopts the view that each court consists of only one judge who is reviewing only one case. Instead, it may be true that a judge in a court could have before him or her litigants, counsel, and expert witnesses familiar with numerous other cases, perhaps even in the same geographic region. And, litigants may have bargained rather seriously over a variety of options in the “shadow of the court” which are then brought before the judge for final settlement.

Institutionally rich environments, such as that found in southern California during the development and implementation of these governance and management systems, provide a better information base for decision making and greater social capital to draw on in institutional design. Side-by-side comparisons of institutional experiments being undertaken in adjacent venues could

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).

provide the kind of information needed for judicial procedures and institutions to be able to assess institutional performance (V. Ostrom, 1964). While the time needed to assess the reliability of knowledge about past resource use by all of the parties and to contemplate alternative allocations of property rights and the need for additional investments in long-term resource management may be substantial (up to almost two decades in one of the cases discussed below), the outcomes are likely to be better than the “quick fixes” that are imposed on resource users who have continued to over-use a resource leading to administrative quick fixes to crises that past neglect has generated (Sterner, Troell, et al., 2006).³

4. Reflexive processes: continuing jurisdiction and the modification of judgments.

Relying primarily on Hart’s description of legal institutions, Knight and Johnson understate the availability and importance of a court exercising continuing jurisdiction over a case. Knight and Johnson do refer to courts being able to monitor conditions, but stop short of a fuller consideration of the possibilities inherent in such monitoring. A court that retains continuing jurisdiction of a case stands in the position not only of a monitor (which is important enough), but also as a forum to which litigants may return to modify the institutional arrangements originally fashioned by an earlier decree. As we shall see below, the role of continuing jurisdiction in providing the opportunity for ongoing processes of learning and modification can in some instances be substantial.

Experience with Institutional Design and Change Using Judicial Decision Making Processes

³ Sterner, Troell et al., 2006 reflect: “Unfortunately, crisis-driven responses do not always provide long-run solutions to complex policy problems. A principal reason is that they may address the symptoms of problems instead of their causes.”

In this paper, we are drawing on our past and current research on a variety of entrepreneurial efforts to design more effective institutions for managing water resources in ways that advance values of efficiency and sustainability (Blomquist, 1992; Blomquist, Schlager, and Heikkila, 2004; E. Ostrom, 1965, 1990; V. Ostrom, 1964, 1971; V. & E. Ostrom 1972; Steed and Blomquist, 2006). Institutional design efforts we have studied relate to: 1) the allocation of the rights to withdraw a defined quantity of water from groundwater basins, 2) the development of market institutions for transferring these rights, once determined, to proprietors who have the most valuable uses for groundwater, and 3) the design of new governmental entities or new agreements among governmental entities to engage in the ongoing management of these basins.

Most of our previous work has been on cases in Southern California, where (as in much of the American West) water resource scarcity emerged through the combination of a semi-arid climate when developed within the incentives of institutions borrowed from wetter regions. Elements of English property law that had entered American practice awarded water and other resource rights to landowners, with little or no limitation on use and not even a requirement to register or record one's use. Spanish establishment of municipalities (*pueblos*) and forts (*presidios*) in California came with authority to use as much water as those settlements required. Influences of both systems persisted in California after statehood in 1850. Around the same time, miners in the West developed a system that came to be known as appropriative rights. Appropriative rights awarded those who staked the earliest claims the right to as much water as the claimant could put to use at that time. Later claimants could stake claims to what remained, but their rights were junior in time, lower in priority, and thus more vulnerable to not being

satisfied when the weather or other circumstances diminished the supply of water. This system of appropriative rights was recognized in California law.⁴

By the early 1900s, these bases for water rights claims sat uneasily side by side in California, with numerous conflicts resulting as one might predict. Complicating matters further, these substantially different water rights doctrines and their associated conflicts had arisen almost exclusively with respect to surface streams. Rights to the use of groundwater were even less well defined. As groundwater law emerged gradually in California, it exhibited a hybrid system combining landowners' rights and appropriative rights, but entirely separate from the hybrid system governing surface water rights—even though in much of the state, surface water use affects groundwater conditions and vice versa. When groundwater use escalated rapidly during the first half of the 20th century, especially in the rapidly urbanizing communities of Southern California,⁵ the stage was set for overuse accompanied by escalating rivalries and deteriorating resource conditions.

Thus, during the early and middle decades of the 20th century, development in Southern California outpaced the amount of water that replenished the underlying ground water basins. The results were falling water levels, compaction of subsurface soils and subsidence of overlying lands. Along the coast, salt water from the ocean intruded into the underground aquifers, potentially rendering unusable the most reliable local source of water supply to support the rapidly growing metropolitan region.

⁴ Hundley (2001) is the standard reference for much of this history

⁵ Hundreds of wells were dug in the Los Angeles area to access the local groundwater supplies. A U.S. Geological Survey completed in 1904 found over 100 wells operating in one basin alone—West Basin, along the coast. The deep-well turbine pump, a new technology introduced in 1909, more easily facilitated groundwater extraction throughout the area.

The Effort to Stop Groundwater Decline and Degradation in the Los Angeles Area

Facing the overuse and prospective loss of the local groundwater sources, the largest water-using organizations in Southern California by the mid-20th century—municipalities and industries—could have attempted to replace those sources entirely with imported water via the legendary aqueducts that were built northeast to the Owens Valley, east to the Colorado River, and north to the Sacramento and San Joaquin rivers.⁶ There were persuasive reasons, however, for individuals within these organizations to devote time and energy to the rescue and preservation of the area’s aquifers even while and after imported water was brought to the region. First, groundwater was (and still is) by far a less expensive source of supply. Second, groundwater basins have reliability advantages over surface water supplies: although groundwater quantities fluctuate in response to use and precipitation patterns, neither the frequency nor the amplitude of their variations is as great as those of surface water supplies fed by seasonal precipitation and runoff. Third, groundwater basins can be used as water storage reservoirs (including use for the storage of imported water supplies). When used for storage, groundwater basins have considerable advantages over surface water reservoirs, especially in locations where the land needed for surface reservoirs is scarce and expensive. Fourth, the institutional rules governing groundwater use had created a form of collective action or commons situation—any municipality or business that abandoned its groundwater use and switched to relying entirely on the more expensive imported water would simply do a large uncompensated favor to the remaining groundwater users. The large water-using organizations

⁶ Imported water was, and still is, essential to Southern California. The stories of these importation projects, and the institutional entrepreneurship associated with them, are well worth telling but would extend this paper considerably. We will focus instead on the development of groundwater management institutions. Besides, the stories of those projects have been told exceptionally well by other authors, on whose accounts we could not improve. Interested readers should consult V. Ostrom 1953, Kahrl 1982, and Hundley 2001.

would have to coordinate their behavior if the groundwater resources they valued were to be preserved for future use and for their mutual benefit.

Much of Los Angeles and its neighboring communities lay within the watershed of the San Gabriel River, which is home to four major groundwater basins. From northeast to southwest, they are the Raymond Basin, Main San Gabriel Basin, Central Basin, and West Basin. Groundwater levels had decreased in all four groundwater basins by the late 1920s. The decline was particularly problematic for West Basin, which bordered the Pacific Ocean and thus had the greatest exposure to saltwater intrusion, which was documented in the basin as early as 1929 (E. Ostrom 1965).

Pumpers in the smaller Raymond Basin were also alarmed by the sharp decline in groundwater levels. While there was no fear of saltwater intrusion for the inland basin, many feared that the basin was becoming critically overdrawn. Between 1922 and 1937, water levels in Pasadena City wells dropped by over 100 feet (Blomquist 1992). Noting this decline, the City undertook legal action to ensure its continued right to groundwater. *Pasadena v. Alhambra* (1937) was initiated in California Superior Court. It was the first basin wide adjudication of groundwater rights in California.

Through the adjudication, the parties and the court endeavored to identify a common basis of pumping rights, and the basin's "safe yield" (i.e., what average annual amount of extractions the Raymond Basin could sustain). These inquiries required the development and use of rather heavily impacted information—all pumpers were not known at the initiation of the litigation, nor were their pumping histories common knowledge or even key characteristics of the basin's capacity. To aid in the development of this information, the initiating parties agreed and the judge ordered that the California Department of Water Resources be appointed as a fact-finding

referee in the case. Some additional parties were joined to the proceeding, and data on the historical water use in the basin were pieced together.

As information gathering proceeded, some of the pumpers and their representatives (attorneys and retained engineering and hydrologic experts) began to negotiate a settlement through which they would modify their pumping amounts to bring the basin back into balance. Given the uncertainties and complexities of California water rights law (then and now), the negotiating parties also believed that developing their own settlement would be preferable to leaving the matter in the judge's hands. A stipulated settlement for the case was presented to the court in 1943. One holdout refused to sign the stipulation, and a brief trial was held in 1944. The judge's ruling later that year supported the stipulated settlement proposed by the litigants. The judge also retained continuing jurisdiction over the case, and appointed the California Department of Water Resources to serve in the ongoing capacity of "watermaster," providing annual reports on groundwater pumping by each of the parties and resulting groundwater levels within Raymond Basin to the court and the parties. Because the negotiated settlement deviated in important respects from certain elements of California water law, the parties sought additional certainty by appealing the trial court judgment to the California Supreme Court, which upheld the judgment in 1949 (206 P.2d 17).

Similar adjudication processes occurred in other groundwater basins. The next one, in West Basin, was initiated in 1945, almost immediately after the entry of the trial court judgment in the Raymond Basin case. In key respects, the West Basin parties and judge (not the same as in *Pasadena v. Alhambra*) followed the example set in Raymond Basin. The California Department of Water Resources was appointed fact-finding referee to determine the basin's characteristics, establish the identity of pumpers, and calculate or estimate their pumping

histories. Parties were added to the adjudication as they were identified. Attorneys and experts retained by the parties, some of whom had been retained by parties in the Raymond Basin adjudication, began negotiating a stipulated judgment. West Basin was significantly larger, however, with many more pumpers than Raymond Basin and more difficult problems to solve,⁷ and the adjudication process was not completed until 1961. The stipulated judgment of the parties was adopted by the trial court, and upheld on appeal. The trial court retained continuing jurisdiction over the case, and the Department of Water Resources was appointed to serve as the watermaster for West Basin as well as Raymond.

Having seen the time and expense consumed in the West Basin litigation, neighboring water users in Central Basin initially hoped to avoid adjudication. While they failed to avoid it, they did succeed in making their adjudication much shorter and less expensive, starting in 1962 and concluding in 1966. Even though Central Basin is geographically larger and contained more parties than West Basin, the Central Basin case benefited substantially from the experience gained by parties,⁸ attorneys, and other experts who had participated in the West Basin adjudication. The processes of identifying additional parties and developing pumping histories proceeded much more rapidly, and a great deal of the hydrogeologic information about Central Basin had been learned during the West Basin litigation because the subsurface outflow of the former constitute the subsurface inflow of the latter so the Department of Water Resources (once again appointed as referee) was able to complete its investigation swiftly. With many of the same characteristics as the Raymond and West Basin judgments, including the retention of

⁷ In addition to West Basin's saltwater intrusion problem, which we have already mentioned was not present in Raymond Basin, essentially all freshwater inflow to West Basin enters underground from the next basin inland (Central Basin), which was itself significantly overdrafted by the 1940s and 1950s. West Basin users were therefore trying to restore a sustainable balance of inflows and extractions at a time when inflows were diminishing.

⁸ A few large pumpers had wells in both West and Central basins.

continuing jurisdiction by the court and the appointment of the Department of Water Resources as watermaster, a program of groundwater management was underway in the Central Basin.

The Main San Gabriel Basin, the second largest groundwater basin geographically in the watershed and also featuring a large number of potential parties, went last. The parties made some significant changes to the “formula” that appeared to have developed in Raymond, West, and Central. Adjudication began in 1968. The institutional capabilities provided by adjudication were still capitalized upon extensively—identification and joinder of parties, appointment of a fact-finding referee, and negotiation among the parties’ representatives in the shadow of the court. New ideas about how to govern and manage the basin emerged during the process, however. Those ideas reflected, to a significant degree, experiences observed and lessons learned in the other three basins in the watershed. The Raymond, West, and Central basin judgments all identified a fixed annual “safe yield,” based on the long-term average characteristics of groundwater levels in response to extractions and inflows. In those basins, each pumper had an adjudicated right to withdraw a fixed quantity of water each year, with all the parties’ rights summing effectively to the determined safe yield of the basin. Consulting engineers retained as expert witnesses by some of the parties in the Main San Gabriel case proposed a variable basin “safe yield,” to be determined each year based on basin conditions.⁹ Instead of fixed quantities, pumpers’ rights would be assigned as percentages (“shares”) of the safe yield. In any given year, a party could extract a quantity of water equal to that party’s share multiplied by the determined safe yield of the basin for that year. The total amount of allowed

⁹ In the Raymond and West basin cases (the Central basin judgment being too new in 1968 to provide much information), the initial determination of basin safe yield had proved over time to be slightly erroneous—basin conditions had turned out to be more favorable than originally estimated. With the fixed safe yield entered in the judgment, and each party’s pumping right also determined and fixed, pumpers were not taking full advantage of what the groundwater basin could sustainably offer.

pumping therefore would fluctuate from year to year based on an assessment of basin conditions.¹⁰ This approach to managing the basin brought with it the question of how—or more important, by whom—the annual determination of the basin’s safe yield would be made. The Main San Gabriel Basin parties settled upon a nine-member body of pumpers’ representatives, which the court would appoint as the Main San Gabriel Basin watermaster. The watermaster group would make the annual safe yield determination, based on data about basin conditions provided by a consulting engineer retained by the watermaster subject to approval by the court. The watermaster function would be expanded, therefore, from solely a data collection function which in the other three adjudicated basins was performed by the California Department of Water Resources into a basin governance function where the representative watermaster body effectively set basin management “policy.” A stipulated judgment containing these elements was negotiated by the parties and presented to the court, which approved it and entered judgment in 1973.

Even while these new ideas were being incorporated into the Main San Gabriel Basin, the processes and institutional arrangements established in the other three basins of the San Gabriel River watershed were being exported to other portions of Southern California (Blomquist 1992). Some of the same attorneys and engineers crossed the San Bernardino Mountains to aid in the 1966 initiation of an adjudication of pumping rights in the Mojave River basin of the “High Desert.” An adjudication of groundwater pumping in the Chino Basin of the Santa Ana River watershed began in 1975. It appears that some of these individuals believed they had discovered

¹⁰ It is intriguing to note that the process of designing the successful “ITQ” system for fisheries in New Zealand was almost stymied by the initial assignment of fixed, quantitative rights to a specific tonnage of fish. When the authorities and the fishers discovered that the calculation of the safe yield could not be sustained over time, they had to enter extremely delicate renegotiations and moved to an assignment of a proportionate right to a safe yield that would fluctuate over time as information about resource conditions could be collected and assessed. See, Yandle and Dewees. 2003

an institutional “formula” for groundwater management, good for what ails any basin anywhere. If that was indeed their belief, they were mistaken. Most water users in the Mojave River area, especially ranchers and smaller landowners, wanted nothing to do with an adjudication and fought it for years, ultimately successfully.¹¹ In the Chino Basin, an adjudication was negotiated by the parties and approved by the court. It did exhibit some of the features of the Main San Gabriel adjudication such as a multi-member watermaster composed of pumpers’ representatives. The Chino Basin adjudication also developed several new and different characteristics that had to be invented in order to overcome landowner objections and accommodate elements of the California Supreme Court’s ruling in another basin adjudication that took place in the San Fernando Valley.¹²

Learning from Experience, and Modifying the Judgments Over Time

With the collapse of the notion of a one-size-fits-all groundwater management formula, and with new developments coming from the Main San Gabriel, Chino, and San Fernando Valley adjudications, by the end of the 1970s the landscape of groundwater management arrangements in Southern California exhibited some variety. Water users were able to learn from the diverse groundwater management experiments being conducted side by side in Southern California, and then return to the courts to make changes, taking advantage of the retention of continuing jurisdiction by the courts in each case.

¹¹ The trial court dismissed the adjudication in 1976. A successful effort to adjudicate and limit pumping in the Mojave River Valley took place during the 1990s.

¹² The San Fernando Valley groundwater basin adjudication case has its own interesting story, but it is not considered at length here because the water rights issues in that case were substantially different from the ones in the four San Gabriel River watershed basins or even in the Chino and Mojave cases. Pueblo water rights claims by the City of Los Angeles, and rights to capture the “return flows” of water imported by Los Angeles via its Owens River aqueduct, were at the heart of the adjudication, appeal, and final judgment in the San Fernando Valley case.

Each of the groundwater basin judgments has been modified over time, due to developments within the basins and to the spread of ideas across basins. The Raymond Basin judgment was amended to increase the safe-yield limit initially set on numbers gathered during the extremely dry period (between 1922 and 1937). The new safe-yield limit focused on years between 1937 and the mid-1950s. The judgment has also been amended to allow for basin recharge—an issue absent from the original document. A third modification replaced the California Department of Water Resources as watermaster with a new Raymond Basin Management Board composed of pumpers’ representatives, similar to the watermasters in the Main San Gabriel and Chino basins. The Raymond Basin board still contracts with the California Department of Water Resources for data collection and the preparation of annual reports on basin conditions.

The West Basin judgment was modified in 1984 to recognize a new category of non-consumptive pumping rights. This modification allowed certain oil companies within the basin the option to withdraw water beneath their operations to clean up areas polluted with hydrocarbons, treat the water to remove the contaminants, and return it underground. Another modification of the West Basin judgment in 1993 provided pumpers with more liberal “carry-over” provisions. Complaining of diminished external sources of water, pumpers in the West Basin successfully argued that they should be allowed additional water extraction of up to 20 percent over their adjudicated right with the recognition that the excess water would be discounted from the following year’s extraction. In addition to satisfying the concerns of individual pumpers, this West Basin modification brought the basin a little closer to the “variable safe yield” formats employed in the Main San Gabriel and Chino basins. While safe yield in West Basin still does not vary from year to year, individual pumpers can reduce their pumping

when other water supplies are plentiful and effectively “bank” a portion of the saved groundwater for withdrawal in a later, drier year.

The judgment in the Main San Gabriel Basin case was modified in August 1990. During the 1980s, much of the Main San Gabriel Basin had become a Superfund site due to the discovery of extensive groundwater contamination by a variety of industrial solvents. Pumpers overlying the contaminated plumes of groundwater had to temporarily retire their wells, rendering their adjudicated shares of the basin safe yield effectively worthless. The judgment modification provided for exchanges of water and money between and among the rights holders in non-contaminated portions and contaminated portions of the basin—pumpers in safe areas could increase their withdrawals and use of groundwater (which remains much cheaper than imported alternatives) and provide offsetting water supplies or money for water purchases to pumpers in unsafe areas.

At the time this paper is being written, parties to the Central Basin judgment are preparing to go back to court to modify the judgment in that basin. One of the innovations that had been introduced over in the Chino Basin adjudication during the 1970s had been allowing individual pumpers to have “storage accounts” in the basin. By contrast, the ability to store and recover water in the Central Basin (and West and Main San Gabriel) belongs to basinwide entities rather than individual pumpers. Some of the largest water users in Central Basin, who also have other water supply options such as imported water, want to be able to store water underground but retain ownership of the stored water. The watermaster would be responsible for maintaining data on the parties’ deposits to and withdrawals from these “stored water accounts” and providing the information on those transactions to all parties in the basin.

Other Developments Relevant to the Management of Groundwater

To combat issues of salt water intrusion, West Basin parties sought additional tools. Because the basin was still overdrawn, interested parties determined immediate action was necessary to stop the inflow of saltwater. The Los Angeles County Flood Control District was tapped in 1952 to construct injection wells along the coast to pump water into the ground to produce a freshwater barrier against the seawater. The injection wells work by making a mound of fresh water which replicates the original underground pressure which kept salt water at bay. Injection wells began operating in 1953 pumping treated Colorado River water supplied by the West Basin Municipal Water District into the groundwater basin. Additional injection barriers and wells were created in 1965, 1971, and 2002. Currently, the wells are operated and maintained by Los Angeles Department of Public Works—formerly known as the Flood Control District.

Injection wells operating along the coast still did not address the underlying issues of the diminished water levels in the Central and West Basins. Officials in both Central and West Basin undertook artificial groundwater replenishment in the early 1950s. The parties acted together to create the Central and West Basin Water Replenishment District in 1959, now known as the Water Replenishment District of Southern California. Property owners and water pumpers were taxed to fund artificial replenishment, and imported water was purchased and spread in the Montebello Forebay area in Central Basin. In addition to recharging the basin directly, the Replenishment District started an in-lieu replenishment program in 1974 whereby pumpers were offered other sources of water to diminish demand for groundwater.

In 1959, the Central Basin Municipal Water District joined with other municipalities in suing upstream water producers within the San Gabriel River watershed, in order to guarantee more access to surface and groundwater in Central Basin. The suit ended in a stipulated settlement in

1965 which guaranteed upstream and downstream rights. A three-member watermaster appointed by the court and composed of representatives of downstream and upstream interests, oversees compliance with the judgment. This judgment and the watermaster arrangement have operated without significant alteration since that time.

Faced with the realities of potential imported water scarcities in the 1990s, water suppliers within the basins have expanded their supply portfolios. In 1991, West Basin Municipal Water District (WBMWD) and the City of Los Angeles entered an agreement to construct and operate a water treatment plant in El Segundo. This action was followed in 1993 when WBMWD built the Brewer Desalter Plant in Torrance to treat groundwater which had become brackish through saltwater intrusion leaking through a portion of the seawater barrier project. Water deliveries from the El Segundo plant began in 1995 and from the Brewer Desalter soon thereafter. Treated water from these plants has been delivered throughout the West Basin for use in industry, landscaping, and in the injection wells. West Basin Municipal Water District is currently the largest producer of recycled water in Southern California. In 2005, they were cited as producing 31,000 acre feet of recycled water (California Water Plan 2005). The Water Replenishment District of Southern California constructed its own brackish water desalination plant, the Goldsworthy Desalter Plant also located in Torrance, in 2001. WBMWD and the City of Long Beach both have pilot ocean water desalination plants in operation and full-scale plants under construction.¹³

¹³ Not everything has gone well for West Basin Municipal Water District. Their role as producer and provider of water in dry years has enabled them to acquire a significant amount of power. Recent years have witnessed some of the darkest hours of water governance in the San Gabriel River Watershed when the West Basin Municipal Water District board president and a board member were convicted of federal charges stemming from corrupt practices in awarding water contracts and taking bribes.

Deliberation, Adjudication, and Diversity

Water users necessarily resorted to existing institutions through which to modify the institutional rules that were exacerbating their situation. In the successful southern California cases, water users repeatedly and purposefully chose decision-making processes that provided for information gathering, deliberation, and negotiation. One form of those processes was the formation of water user associations, which were extremely valuable discussion forums but lacked the formal authority to change the rules governing resource use. The decision making processes chosen most often for that purpose were judicial ones.

Water users usually did not take issues into the courts in order to have them decided by a judge or jury. They went to the courts in order to take advantage of the information-gathering processes of a lawsuit, and the pressure of bargaining "in the shadow of the court" in order to negotiate a resolution of issues among the affected parties.¹⁴ Negotiating a stipulation means attaining a consensus or near-consensus of the parties, however opposed their interests may be initially. Water users repeatedly opted for this process, despite the fact that it often consumed several years of time and energy and considerable sums of money. Moreover, the stipulated judgments they reached always included retention of continuing jurisdiction by the court, which allows parties who subsequently became dissatisfied with the judgment or its administration to petition the court for relief or modification.

Water users such as the City of Pasadena found it advantageous to address their water problems through the California courts for a number of reasons. Court action could initially encompass all potentially relevant participants. Eventually through sorting out the dispute and

¹⁴ Indeed, and perhaps underscoring Knight and Johnson's observations about the limitations of courts, the only Southern California groundwater basin adjudication decided by a judge was the botched 1968 decision in *Los Angeles v. San Fernando*, which was reversed on appeal.

resolving it authoritatively the set of relevant participants was authoritative determined and agreed upon by those involved. 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.

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. In the Southern California cases, however, the results of institutional experiments being conducted nearby did feed back into the judicial decision-making process and affected (sometimes quite markedly) the design and adoption of institutional changes. Thus, learning from one case helped the participants in nearby locations to craft rules that experience with similar rules had shown to be workable in practice but that differed in ways important in a particular setting.

Comparison with Property Rights to Groundwater in Australia and Arizona

Southern California shares a semi-arid climate with large regions of Australia where water scarcity can become quite severe. This allows a modest comparison of the consequences of using the courts to facilitate a determination of initial groundwater rights and as a forum for learning, adaptation and change over time. While Australian land owners hold complete property rights to the land that they use for farming or other purposes, rights to the use, flow and control of all surface and groundwater are vested in the State (Government of Australia, 2000, Section 19). On the other hand, landowners are allowed to take groundwater and use it for any purpose “unless there is a moratorium notice or a water resource plan that limits or alters the water that may be taken” (Government of Australia, 2000, Section 20). Thus, the legal structure surrounding the use of groundwater in Australia differs markedly from that of Southern California. Most of the authority for proposing new rules or adapting rules-in-use lies with the state governments rather than with the water users.

Even though both areas drew considerably on English Common Law, during the 20th century, the Crown declared itself the sole owner of all groundwater in Australia with the administrative responsibility for developing management and licensing systems allocated to the States (McKay, 2006). Until the 1990’s, however, many of the states did not cap the number of wells or the quantity of water extracted. Even when there were regulations issued, groundwater was considered a separate resource from surface water and imprecise management measures were obtained regarding the sustainable yield (Evans, et al., 2006). Consequently, no judicial mechanisms existed that water users could initiate to cope with drastically falling water tables in some regions and rising salt water in others. While groundwater use is estimated to have

increased by 58% between 1983 and 2000 (NLWRA, 2001, p. 64) such information is difficult to estimate reliably because less than 20% of the State organized management units have required meters to be placed on wells. While one does not know for certain whether being able to invoke equity jurisprudence and use the courts to determine safe yields and the allocation of groundwater rights, would have reduced the severe problems now associated with trying to design effective water institutions, but large-scale administrative decision-making does not appear to have enabled effective fact finding, learning and adaptation to have occurred.

We don't have to go as far away as Australia to find other ways of adopting or not adopting institutional arrangements that enable participants to obtain accurate information about past uses and to learn from the use of new rules in ever-changing environments. A brief comparison of how water law evolved in Arizona would provide still further insights.

Groundwater is a major source of water for Arizonans. As of 2001, groundwater provided about 40 percent, or 2,724,000 acre-feet, of the state's consumptive water use (Blomquist, Schlager, and Heikkila 2001).

Prior to 1980, groundwater in Arizona was governed by the reasonable use doctrine. Landholders above a groundwater basin had the right to pump as much water from the basin as they wanted as long as they put it to reasonable use. The reasonable use doctrine does not establish pumping limits. Thus, overlying landholders can pump more water than is naturally replenished, causing water tables to decline, subsidence to occur, and surface vegetation to die. By the mid-twentieth century, Arizona landholders began to experience these types of problems (Mann 1963). The increased reliance on groundwater in the Tucson area led to the depletion of approximately 11 percent of the area's groundwater supplies since 1940 (Water Resources Research Center 1999).

In 1980 Arizona passed the Arizona Groundwater Management Act, which transformed the open access condition of the most heavily used basins to one of limited access and managed use. Alarm over groundwater depletions, however, was not the only, or necessarily the primary, motivation for the adoption of the 1980 Act. Rapidly growing cities needed additional sources of water. Much of the available groundwater sources in the areas outlying the cities were owned and controlled by farmers. State court decisions made it difficult for cities to acquire and transport such water to their service areas (Lesly and Belanger, 1988). Cities were reluctant to buy groundwater from farmers because they felt that farmers were the primary cause of the overdraft problems (ibid). That left the Central Arizona Project, designed to bring Colorado River water eastward across the desert to Phoenix and then south to Tucson, as the most promising source of future water supplies.

However, the U.S. Secretary of the Interior credibly threatened to eliminate funding for the CAP unless the state moved to strictly regulate groundwater use (ibid). In response to threats to the continuing viability of groundwater basins and to the CAP, representatives of cities, farmers, and mines, state legislators, and the governor negotiated an agreement concerning the management and use of groundwater that the legislature passed in 1980.

The 1980 Arizona Groundwater Management Act established a goal of “safe yield”, to be achieved by 2025, for the state’s most heavily used groundwater basins, those underlying the Prescott, Phoenix, and Tucson metropolitan areas. Achieving safe yield meant balancing the quantity of groundwater withdrawn with the quantity of water that replenishes an aquifer, both naturally and artificially. In the basin underlying the agricultural area between Phoenix and Tucson, however, the goal was to substantially slow the mining of groundwater. The State designated each of the basins underlying the major municipal regions and the basin underlying the

agricultural center of the state as an “active management area” (AMA), over which the Arizona Department of Water Resources has administrative authority. All other basins in the state continue to be governed by the reasonable use doctrine.

The goal of safe yield was to be achieved through a variety of mechanisms. Mines and farmers were granted quantified and partially transferable rights to specific quantities of groundwater. Farmers’ groundwater rights were conditioned by two factors. First, the rights were subject to conservation requirements -- the acre-feet of water per acre that farmers were given would slowly be ratcheted down over time. Second, farmers were not allowed to open new lands to irrigation. Only existing irrigated acreage would be eligible for groundwater use. Under the 1980 act, farmers thus received “Grandfathered Rights” based on historic use, which annually averaged approximately five acre-feet of groundwater per acre. Irrigation Grandfathered Rights can be converted to non-irrigation Grandfathered Rights when farmland is transferred to nonagricultural use, but these rights cannot be severed from the land. Mines and other industrial users were granted another type of grandfathered rights also based on historic use, which are transferable to other locations.

Cities, towns, private water companies, and water districts were assigned "service area rights" rather than quantified groundwater rights. Service area rights are based on gallons of water per day per customer served, rather than feet of water per acre of land. The per-capita service area right is subject to increasingly strict conservation requirements over the life of the act. The 1980 Act did not immediately place direct limits on the amount of groundwater that could be pumped by municipalities, however, the Act did direct the Arizona Department of Water Resources to develop rules creating an assured water supply program. The assured water supply program would require municipal and residential water purveyors to demonstrate that

they have water of adequate quality and quantity to supply all new and existing uses for 100 years.

By the mid-1980s, multiple water conflicts had emerged in the context of the 1980 Act. The Department of Water Resources struggled to define assured water supply rules that were in accord with the safe yield goal of the Act. Some cities, in anticipation of assured water supply rules, which would almost certainly place strict limits on the use of mined water from managed basins, purchased large ranches overlying basins governed by the reasonable use doctrine just for the water rights. Known as “water farming”, cities intended to develop the groundwater on the ranches and transport it to their service areas (Checchio 1988).

Municipal purchases of ranches alarmed rural residents who feared that their water would be pumped out from under them. While municipalities searched for additional sources of water in rural areas, developers attempted to stall the adoption of assured water supply rules. Developers were in a precarious water position. Since they were not granted contracts to Central Arizona Project water they must either tie into a municipal utility or pump groundwater. Assured water supply rules would eliminate groundwater pumping, restricting developers from building out their lands. Finally, water purveyors who wanted to begin experimenting with storing surplus surface water underground realized that state law prevented such activity. State law did not recognize recharged water, and water purveyors feared that they would lose the rights to any water that they stored underground.

A 1990 symposium at the University of Arizona, convening policymakers, water resource managers, and academics reviewed the first ten years of experience with the GMA (“Debate, Discussion...”). With a few exceptions, the reviews were sharply critical. The compromises needed to achieve a statewide legislative and regulatory framework had left the GMA and the

state Department of Water Resources without some of the finer-grained instruments that would be needed to arrest overdraft and restore groundwater conditions in the particular circumstances of each active management area. Although much credit has been given, and justifiably so, to Bruce Babbitt, the Arizona governor who brokered the GMA in 1980, it is fair to say that the deliberative process associated with that institutional change was far from ideal. It consisted of negotiation among top interest group representatives, meeting privately in the governor's office under the threat of withdrawal of federal funding for a major state water project. There was little opportunity in that decision making process for development of information, crafting of tailored solutions for diverse situations, or adoption of lessons learned in other jurisdictions. A deal was reached, the GMA was enacted, and the CAP was built, but a long clean-up process lay ahead.

Over the course of the next decade, several of the problems with the GMA were addressed, mostly through legislative and regulatory activity some of which was prompted by litigation (Blomquist, Schlager, and Heikkila 2004). Although successful modifications have therefore been made, the process of institutional change in Arizona could not draw upon the institutional diversity that might have facilitated competitive experiments and experiential learning. Each AMA established by the GMA had the same systems for allocating and transferring water rights, the same conservation targets, the same administrative structure. A problem that arose in one or two AMAs had to be addressed for all.

Since 2005, new efforts are underway to extend active groundwater management to the remainder of Arizona. Once again this is being approached on a statewide, one-size-fits-all basis.

The Importance and Implications of Using Judicial Forums in Crafting Institutional Change.

The use of judicial arenas in Southern California provides an important insight into one method that can be used for accomplishing institutional experimentation, assessment, and change. We hope our analysis contributes to the ongoing and lively interdisciplinary pursuit of understanding the diversity of institutional arrangements that may be invoked to facilitate gathering accurate information and gaining agreement at the time of institutional change. We are also interested in understanding what factors contribute to design and adaptation of robust institutional designs. All other things being equal, we are willing to argue that: (a) institutional diversity, which yields richer information about institutional performance, combined with (b) the availability of institutional arrangements through which people can monitor and modify their institutional experiments based (at least in part) on that richer information base, would be associated with greater prospects for institutional robustness. Robust institutions would be those that can quickly adapt to changing economic, political, social and ecological conditions that may threaten the performance of rules designed and implemented at one time period in later eras.

Conversely, the absence of either (a) or (b) would contribute to institutional vulnerability. We have presented a very short overview of developments in Australia and Arizona where substantial authority was transferred to popularly elected governments but whose decisions about water rights were applied to very large regions of a country. Until recently, little data was obtained in these areas about either the amount of water withdrawn from diverse groundwater basins or the sustainability of the use patterns that had evolved. Without accurate data and methods to involve water users in the design of better institutions, problems of overuse are likely to remain dormant for some time before emerging as pressing issues. We hope to develop a more extended research program on the diagnosis of complex, nested social-ecological systems and which factors may contribute to problematic outcomes, better information about the structure

of these systems, and successful adaptation and reform (see Anderies, et al., 2004; E. Ostrom, forthcoming). Returning to the study of groundwater institutions in Southern California to examine their adaptability and robustness to disturbances over time will be a core part of this research program (Steed and Blomquist, 2006). Institutional theorists need to study how institutional rules are first designed and implemented as well as how learning, adaptation, and change does or does not occur.

We appreciated the contribution of Knight and Johnson (2007) to understanding how institutional forms affect institutional performance. We hope our discussion of a greater range of possibilities available in judicial forums complements the significant contribution they have made.

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