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Climate Vulnerability and Adaptation Study for California: Legal Analysis of Barriers to Adaptation for California's Water Sector

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CLIMATE VULNERABILITY AND ADAPTATION STUDY FOR CALIFORNIA

Legal Analysis of Barriers to Adaptation for California's Water Sector

A White Paper from the California Energy Commission's California Climate Change Center

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PREFACE

The California Energy Commission's Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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ABSTRACT

This project focused on the legal and institutional framework associated with California's water rights allocation system, and identifies changes to that framework that would facilitate adaptation to climate change. Since such changes may be difficult to accomplish, the project focused largely, but not exclusively, on changes that may be politically feasible now or in the future.

There is already conflict in California over water allocation, and climate change will exacerbate that conflict by increasing demand and decreasing supply. Adaptation will be needed both to address already unavoidable impacts from historical emissions, and to address impacts from future emissions. To identify changes that would facilitate adaptation this study looked at recent legislation, policy proposals, and white papers addressing water reform; and off-the-record interviews were conducted with individuals familiar with California water law. Having an accurate record of who is diverting water in California, and in what quantity, is the single most important step towards preparing for climate change, and the recommendations reflect that.

For groundwater, the changes identified would (1) expand groundwater monitoring and reporting requirements, (2) expand groundwater planning requirements, and (3) require the State Board to improve groundwater management and to prevent the waste or unreasonable use of groundwater. For surface water, the changes we identify would (1) require the State Board to provide information about efficient agricultural water management practices, and streamline State Board procedures for enforcement actions for the waste and unreasonable use of water, (2) increase the enforcement of and penalties for failing to file a Statement of Water Diversion and Use and for illegal diversions, (3) require all beneficiaries of the water rights system to bear the cost of activities related to the administration of those rights, and (4) expand reporting requirements to require diverters to state what they believe their water rights to be.

Keywords: Water rights administration, California, climate change, adaptation, groundwater, surface water, State Water Resources Control Board

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EXECUTIVE SUMMARY

Background

There is already conflict in California over how water should be allocated in times of drought, and climate change will exacerbate that conflict by increasing demand and decreasing supply.[1] Population increases will further increase demand. The California Department of Finance estimates that in 2050, California's population will be more than 60 percent greater than in 2005, increasing from about 36.7 million people in 2005 to an estimated 59.5 million in 2050. The legal regime for managing water was not designed for dealing with these issues, and changes will be required.

Purpose

This paper looks at legal changes that will facilitate adaptation to the expected impacts of climate change. According to the Intergovernmental Panel on Climate Change Fourth Assessment report, adaptation will be needed to address impacts from the warming which is already unavoidable due to historical emissions. Adaptation in the water sector will eventually occur. The key issue, then, is not whether adaptation will occur but rather how well organized (or chaotic) it will be, how promptly it will occur, how costly it will be, and how effective and comprehensive it will be in offsetting the climate-induced changes. In economic theory, adaptation is instantaneous. In California's water sector, however, that is not the case. There are several reasons for this. First, water governance involves multiple actors, acting on many different scales–individual, local, basin-wide, regional, statewide and national. Reaching agreement would be difficult even apart from the inevitable conflicting interests of different actors. Second, adaptive action is mediated by institutions that govern the allocation of costs and benefits and the pace of decision-making; institutions are sometimes resistant to change. Last, the consequences of climate change and potential adaptations are not known with certainty, nor do all parties agree on them. These factors influence both the timing and nature of the adaptive actions that occur.

Adaptive measures will necessarily address risk: risk measurement, risk assessment and prediction, risk management, and risk pricing. At present, water management agencies in California deal with risk in a somewhat problematic way. Risk is not modeled in a probabilistic manner; instead, the limited historical hydrologic sequence is used as a measure of risk, even though it is a highly imperfect measure, and one that likely underestimates the full range of uncertainty, even in the absence of climate change. The California water rights system does not explicitly or transparently allow for risk assessment, and does not manage for risk. Water

[1] There are at least two reasons for the conflict. First, diverting water for use *off-stream* and preserving natural flows *in-stream*, or allocating diversions to agricultural versus urban users, are still inherently rivalrous uses of the same resource. Second, some of the remedial actions are costly, and the joint cost allocation is a zero-sum game. Hence, there has been, and still remains, an ineluctable element of conflict.

allocations are thought about in terms of certainty and entitlement, instead of in terms of risk sharing.

Objectives

This project focused on the legal and institutional framework associated with California's water rights allocation system, and identified changes to that framework that would facilitate adaptation to climate change. For successful adaptation to occur, there are a number of prerequisites, almost none of which are currently in place. First, monitoring and measurement are needed to establish a baseline of the resource needed, and, once that baseline is known, to measure the pace of change in both supply and demand. Second, the water governance structure and system of property rights in water must be sufficiently flexible to accommodate the consequences of climate change. Last, there needs to be an effective governance mechanism for collective action in order to undertake public (as opposed to private) adaptations. Since such changes may be difficult to accomplish, the project focused largely, but not exclusively, on changes that may be politically feasible now or in the near future. To identify changes that would facilitate adaptation this study looked at earlier recommendations for strengthening the power of the State Water Resources Control Board ("State Board" or "Water Board") to administer and enforce water rights in California and the legislation that was ultimately adopted in 2009. It also looked at a number of recent policy proposals and white papers addressing water reform. In addition, we conducted off-the-record interviews with a number of individuals familiar with California water law.

Conclusions

This study identified changes that would aid in adaptation in two areas: groundwater and surface water. For groundwater, the changes would (1) expand groundwater monitoring and reporting requirements, (2) expand groundwater planning requirements and require the State Board to provide information about groundwater management best practices to local agencies, and (3) require the State Board to prevent the waste of or unreasonable use of groundwater. For surface water, the changes identified would (1) require the State Board to provide information about efficient and wasteful agricultural water management practices, and streamline State Board procedures for enforcement actions pertaining to the waste and unreasonable use of water, (2) increase the penalties for failing to file a Statement of Water Diversion and Use and for illegal diversions, (3) require all beneficiaries of water rights to bear some of the cost of activities related to the administration of those rights, and (4) expand reporting requirements so that diverters are required to state what they believe their water rights to be.

Section 1: The Rationale for Reforming California's Water Rights Administration Now Rather Than Later

"If our climate should change for the worse, our water laws should change for the better" (Trelease 1977, p.83).

Thirty-five years after that sentence was published, much more still needs to be done to improve water law in the face of climate change. This white paper attempts to identify some changes that would improve water law, with a focus on those changes that may be feasible to accomplish in today's political environment.

There are a number of reasons why it would be preferable to reform California's water rights administration sooner rather than later. First, as described in more detail below, California's climate has already changed, and those changes and their associated impacts are projected to continue and, in some cases, accelerate. Second, as discussed in Section 3, if the state's past response to drought is an indicator, California government will take action to respond to these changes—either by agency action, by legislation, or by both. Planning for such actions lowers costs, in part because taking action now may prevent the need for costly emergency action later[2] (Lund et al 2008, p. 77). Last, the longer the state waits to make changes, the more stakeholders will make investments and take actions based on existing practices. Against this background of change, it is preferable to take action before the next crisis or drought occurs.

1.1 Changes to California's Climate that Have Already Occurred

A 2009 report prepared for Governor Schwarzenegger by the California Environmental Protection Agency collected information about the changes that have already taken place (Cal/EPA 2009a, 2009b). Among the changes already occurring are the following:

- The state is warmer, and water is less available in the late spring and summer. Over the past century, minimum and mean temperatures have increased at a rate of about 2 degrees Fahrenheit, and day and night temperatures have shown rises since the mid-1970s, the period in which greenhouse gases have had the greatest influence. (Cal/EPA2009b, pp. 43-44)[3] Trends are similar in the Sierra Nevada, where snowpack storage has played an essential role in providing water to Californians. There, the greatest warming has occurred in the late winter and spring, suggesting earlier and

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[2]For example, the cost of a temporary catastrophic failure of the Delta levees is estimated to range from $8 billion to $15 billion—many times the cost of reducing or ending Delta exports. Ending exports, which would be more costly than reducing exports, is estimated to cost just a fraction of the cost of levee failure, from $1.5 billion to $2.5 billion (Lund et al. 2008, p. 77).

[3] There is speculation that the lack of a significant change in maximum temperatures reflects cooling from evaporative cooling cause by irrigation (Bonfils et al. 2008, p. S53).

larger runoff (Cal/EPA2009b, pp. 45-46). As a result, there will likely be less water available later in the growing season, which is particularly problematic because temperatures have increased in California's Central Valley since the 1970s, (Cal/EPA2009b, p. 49) leaving the state in a situation where more water is needed later in the growing season, while less is available. In addition, increased tree mortality in the Sierra Nevada has coincided with this increase in temperature, suggesting the increased temperatures may contribute to the increased mortality (Cal/EPA2009b, p. 127).

- The drought experienced during the early twenty-first century was a basin-wide phenomenon through the West and Southwest, and the low–flow conditions of the Colorado River during that time, may be by some measures the lowest since the drought of the late sixteenth century (Webb et al. 2005).

- Extreme heat events have increased, with sharp and unprecedented increases in nighttime heat waves in 2003 and 2006 (Cal/EPA2009b, p. 57). Extreme heat events that occur during the summer can lead to heat-related deaths, decreased agricultural production, and increased demand for electricity (Cal/EPA2009b, p. 57). The 2006 heat wave resulted in an additional 16,000 emergency department visits. (Cal/EPA2009b, p. 125).

- Cool winter temperatures, essential for crops to set fruit, are decreasing. Many crops grown in California require a certain number of hours below a certain temperature in order for them to become dormant and then set fruit. For example, in order to set fruit, almond trees require between 400 and 700 hours during the cold season to be below about 45 degrees Fahrenheit, while pomegranate trees require between 100 and 200 chill hours (Baldocchi and Wong 2008). Of the climate stations analyzed, about 75 percent are experiencing "a significant and negative trend in winter chill hours," with the decreases ranging from about 50 to 500 hours per decade (Baldocchi and Wong, p. S164).

- The timing of spring runoff has advanced. The percentage of the annual runoff that occurs during the spring snowmelt period has decreased in many major river systems over the twentieth century, especially in the second half. Among those rivers experiencing decreases in spring river runoff are the Sacramento River system (10 percent decline), the San Joaquin River system (7 percent decline), the Kings River (6 percent decline), the Kern River (10 percent decline), the Trinity River (11 percent decline), the Truckee River (15 percent decline), and the Carson and Walker Rivers (5 percent decline) (Cal/EPA2009b, pp. 77-78).

- Sierra Nevada glaciers, which are indicators of climate change and which also provide important cool water to alpine ecosystems, have shrunk significantly over the past century. Glaciers are especially important in low snow years because they provide water to streams long after snow melt. Of fourteen glaciers examined in a recent study, the area change between 1903 and 2004 ranged from a reduction 31 percent to a reduction of 78 percent in size, with an average reduction of 55 percent. If those trends continue, most will disappear in 50 to 250 years (Basagic and Fountain 2011, pp. 317–330, p.327).

- Sea levels have also risen over the past century. Along the California coast, sea levels have risen between three and nine inches over the last century, with variations caused by tectonic activity and land subsidence. Sea levels in La Jolla have risen nine inches, while sea levels at the Golden Gate have risen eight inches. These increases, which are amplified when combined with storm surges, could lead to flooding, erosion, saltwater intrusion into aquifers, and problems with bridges and roads (Cal/EPA2009b, p. 92).
- Large wildfires (over 1,000 acres) and fire season length are increasing, with sharp increases starting in the mid-1980s. When comparing two different 16-year periods (the period 1970 to 1986 with the period 1987 to 2003), for the later period the total acres burned increased by six times, the wildfire frequency increased by four times, the length of the wildfire season increased by 64 percent, and the duration of individual fires increased from one week to about five weeks (Cal/EPA2009b, p. 131).
- There are many other changes. Lake Tahoe is warming and losing clarity especially since the 1970s (Cal/EPA2009b, pp.96, 98). The temperature of coastal waters is increasing which in turn creates sea level rise and reduces biological productivity (Cal/EPA2009b, pp. 109–110). Forest and alpine vegetation patterns are changing (Cal/EPA2009b, p. 137, 143).

These changes demonstrate why water rights reform should be undertaken sooner rather than later, so that the state can best and most cost-effectively adapt to the changes that have already occurred and to those that may occur in the future.

Section 2: Overview of California's Surface Water and Groundwater Resources and Laws

2.1 California's Surface Water Resources

California's water resources vary from year to year, from region to region, and from season to season. California relies on its extensive water infrastructure and water rights systems to provide surface water to users across the state. Precipitation (mostly rain and snow), the primary source of the state's water supplies, is highly variable. About 80 percent of California precipitation falls between October and March, while about 75 percent of the water use occurs between April and September (Doremus and Hanemann 2007, p. 57). Most precipitation falls in the mountains in the north and east of the state, while most water is used in the central and southern valleys, and along the coast (DWR 2009, Vol. 1, p. 4–5). Annual precipitation is highly variable; there are frequent wet years and dry years, and relatively few average years (Doremus and Hanemann 2007, p. 57). In addition to precipitation falling within its borders, California receives water from the Colorado River under a series of treaties, laws, compacts, contracts, and agreements. Those limit California's use of Colorado River flows to 4.4 million acre-feet plus not more than half of any waters not otherwise apportioned (Littleworth and Garner, p. 320). Among the California entities receiving water from the Colorado River are the Palo Verde Irrigation District, the Yuma Project Reservation District, the Imperial Irrigation District, the Metropolitan Water District of Southern California, the City of Los Angeles and others on the coastal plain, and the County of San Diego (Littleworth and Garner, p. 323). In an average year, agricultural users use approximately 34 million acre-feet of applied water, urban users use about 9 million acre-feet of water, while 39 million acre-feet are dedicated to environmental uses (Littleworth and Garner 2009, p. 8). The infrastructure and the water rights systems are based on historical hydrology, however, and that hydrology has already changed and is expected to continue changing (DWR 2008a, p 4).

2.2 California's Groundwater Resources

Historically, California's water users have turned to groundwater in times of shortage. Recent reports from both the California Department of Water Resources (DWR) and the National Aeronautic and Space Administration (NASA), however, suggest that groundwater is being pumped at an unsustainable rate. That results in overdraft, which occurs when more water is extracted from California's aquifers than is naturally replenished. The DWR estimates that groundwater withdrawals exceed groundwater replenishment by an estimated one to two million acre-feet per year (DWR 2003 pp. 2, 29). Satellite data collected by NASA and analyzed by University of California, Irvine scientists show an even higher rate of overdraft. Those data suggest that the aquifers in California's Sacramento and San Joaquin drainage basins shed more than 25 million acre-feet from October2003 to March2010, suggesting that overdraft in just those two basins has increased during that 6.5 year period to an estimated 3.8 million acre-feet per year (Famiglietta et al. 2011). The actual level of withdrawals is not known, however, because groundwater users are largely not required to report their extractions.

2.3 Current Difficulties and Gaps in California's Administration of Water Rights

California has three major, different, legal schemes that govern water rights: one for riparian rights, a second for appropriative rights, and a third for percolating groundwater. In addition, some users have a contractual right to use water from one of the two major water projects in the state: the Central Valley Project and the State Water Project.

Regardless of the type of water right, the use must be "reasonable." The California constitution prohibits "the waste or unreasonable use" of waters of the state, and further notes that the right to water "shall be limited to such water as shall be reasonably required for the beneficial use to be served."[4] This is called the "reasonable use doctrine." In addition, Water Code Section 275 authorizes the State Board to "take all appropriate proceedings or actions" to "prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion."[5] The State Board has rarely exercised its authority under these provisions, but that authority nonetheless exists. In a different but not unrelated context, Hanemann and Dyckman (2009) have noted the Board's chronic failure to exercise authority which it possesses and have identified some structural factors that may explain the Board's passivity. If the Board were to become more pro-active, this authority provides a potential means of facilitating adaptation.

Following is a brief discussion of each of the three major water rights systems, followed by a discussion of outside constraints. The different legal schemes developed in response to different challenges.

2.4 Riparian Rights: The Rights of Landowners to Use Stream Flows

Riparian rights, which pertain to surface waters, have their basis in English common law, and allow the owner of land that contains or abuts a stream or other water body to use some of the water from the stream for reasonable and beneficial use on that piece of land (Littleworth and Garner 2007, pp. 38–39). Upon statehood, California courts were the source of water law, and they relied on judicially developed doctrines that linked water rights to property, i.e., the doctrine of riparian rights (Littleworth and Garner 2007, p. 31). Riparian rights were established by California's first legislature, shortly after California entered the Union in 1850. Generally, under a riparian right, water from the stream cannot be used on land that does not border the stream. There are other features of riparian rights that are important. First, riparian rights are "correlative," which means that in times of shortage, all riparian users must reduce their water consumption (Littleworth and Garner, p. 47). Earlier use of water does not give a riparian user any priority against later riparian users. Second, the right to water is not to a specific quantity of water, but rather the water used must be reasonable with respect to other water rights holders,

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[4] Cal. Const. Art. X §2. What actually constitutes *unreasonable use* is still poorly defined, thus limiting the practical significance of this constitutional requirement.

[5]The full text of Water Code Section 275 states, "The department and board shall take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state."

both riparian and appropriative (Littleworth and Garner, p. 41). For example, an upstream riparian rights holder could not use all of the water from a stream in wasteful manner if that left the downstream users without any water to use productively. Third, riparian rights generally remain with the land even when the land is transferred to another owner, and are not lost simply through non-use (Littleworth and Garner, pp. 44, 46). Last, riparian rights generally do not extend to storage (Littleworth and Garner, p. 42). Generally, riparian rights and overlying rights are "prior and paramount" to appropriative rights, but courts have relied on the reasonable use doctrine to limit the rights of riparian and overlying users (Littleworth and Garner, pp. 47–48; *City of Barstow v. Mojave Water Agency* (2000); 23 Cal. 4th 1224, 1250-5).[6]

2.5 Appropriative Rights: The Rights of Non-Adjacent Users to Use Water

Appropriative water rights, which also pertain to surface waters, developed during California's gold rush because miners needed water at non-riparian locations, often on land that they did not own (Littleworth and Garner, p. 49–50). Ownership of waterways rests with the state, but appropriators gain a "usufructory" right to make use of the water. The right arises from the use of water, and is a right to divert and use a particular amount of water, in a particular place (not necessarily riparian), and for a particular purpose. In contrast to riparian rights, appropriative rights are first in time, first in right.[7] What that means is that earlier users, typically called "senior" rights holders, have priority over "junior" rights holders. In a dry year, senior rights holders may receive their entire allocation, while junior rights holders may receive nothing. There are some restrictions—the use is subject to the reasonable use doctrine previously described. Also, under the doctrine of prescription, an appropriator may lose water rights if the water is not used for a period of five or more years, however, in California that doctrine does not apply to public entities.[8] Appropriative rights generally limit withdrawals to a particular interval of time (e.g., starting on a particular date and ending on another).

Despite potentially serious consequences for junior rights holders, appropriative water rights are poorly quantified. Thus, the formal legal rights of senior rights holders may be less useful in practice because of the potential controversy over the dating and quantity of rights.[9] The early practice was for a miner to post a notice at the stream, and then divert water for mining purposes. In 1855, this practice was adopted by the California Supreme Court in *Irwin v. Phillips*, 5 Cal. 140 (1855). In that case, the Court held, "if they [the waters of a stream] have been already

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[6]Because of the lack of specificity as to the quantity of water provided by a riparian right, it has been observed that "[A]ny fairness benefits are out-weighed by the extreme uncertainty of the rule."(Tarlock, p. 889).

[7] Water Code §1450, Civ. Code §1414.

[8] Civ. Code §1007.

[9] Enforcing appropriative water rights is costly and likely to generate controversy. For this and other reasons, the rule of prior appropriation has been described as "more rhetoric than rule," (Tarlock 2000, pp. 883, 898), and that applies with particular force in California.

diverted, and for as high and legitimate a purpose as the one he seeks to accomplish, he [the junior user] has no right to complain, no rights to interfere with the prior occupation of his neighbor and must abide the disadvantages of his own selection" (*Irwin v. Phillips et al.*, 5 Cal. 140 (1855), 147. The notice system changed over time—from 1872 to 1914 notice to the county recorder was required, although there was no mechanism for reconciling diversion claims with stream flows, and no verification that actual diversions were (and are) consistent with the claimed diversion right (Civ. Code §1415; Littleworth and Garner, pp. 50–51). Since 1914, appropriators have been required to obtain a permit from an agency created under the Water Commission Act of 1913 to manage surface water rights.[10] That agency has evolved into today's State Board.

Aside from issuing rights to appropriate water, after determining that surplus water is available and that the proposed diversion satisfies the criterion of reasonable and beneficial use and is in the public interest, the Board has only "a limited role in resolving disputes and enforcing rights of water holders, a task left mainly to the courts" (*United States v. State Water Resources Control Bd.* (1986) 182 Cal. App. 3d 82, 104 (italics omitted).[11] The Board also has only a limited ability to monitor diversions and enforce the seniority of post-1914 appropriative rights. It was not until 1965 that the reporting of diversions was required. However, that legislation imposed no penalty for failure to report, and it exempted water diverters in the Delta from the reporting requirement. In consequence, the reporting requirement was often evaded in areas where it applied.[12] Where water use is reported, it is not generally verified.[13] Moreover, some diversions occur that are not legally authorized. With respect to the Delta, the Board staff concluded that:

> "[I]t is clear that that the State Water Board has permitted less than a third of the diversions occurring in the legal Delta. The State Water Board does not know at this time how many of these unpermitted diversions may be associated with legitimate riparian

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[10]Chapter 586 of Statues 1913.The State Water Board does not have permitting and licensing authority over pre-1914 appropriative water rights or riparian rights. "The State Water Board has very limited information on water use for either of these [two] classes of water rights, and the little information it does have has not been synthesized and is not maintained electronically." (State Board memo to Delta Vision Blue Ribbon Task Force, 9-26-08, p. 1).

[11] The ruling goes on to explain that: "Because water rights possess indicia of property rights, water rights holders are entitled to judicial protection against infringement, e.g., actions for quiet title, nuisance, wrongful diversion or inverse condemnation. ...It bears reemphasis that the Board's role in examining existing water rights to estimate the amount of surplus water available for appropriation does *not* involve adjudication of such rights"(*United States v. State Water Resources Control Bd.* at 104 (italics in original).

[12]In 2008 the Board staff estimated "that 68% of permit and license holders and 65% of diverters who should file a Statement [of Water Diversion and Use] fail to report" (Memorandum from Dorothy Rice, Executive Director to John Kirlin, Executive Director, Delta Vision Blue Ribbon Task Force, June 2, 2008, p. 2.)

[13] Referring to the water use information reported to the Board, the staff stated "there has been no verification of the quality of this information except as part of limited enforcement actions" (State Board memo to Delta Vision Blue Ribbon Task Force, 9-26-08, pp. 1-2).

or pre-1914 claims of water right, or how many require a water right permit but do not have one. The State Water Board also does not have an estimate of the illegal diversions throughout the Delta watershed" (Memorandum from Dorothy Rice, Executive Director to John Kirlin, Executive Director, Delta Vision Blue Ribbon Task Force, June 2, 2008, pp. 1-2). [14]

The Board's records are generally limited to the "face value" of permits that it has authorized. The Board staff noted that, in the case of the Delta, the total face value of post-1914 appropriative water rights permits and licenses there amounts to more than eight times the average annual natural flow in the watershed, and more than three times the observed maximum annual flow (State Board memo to Delta Vision Blue Ribbon Task Force, 9-26-08, pp. 2-3).[15] The staff went on to state: "Actual use under existing water rights is clearly a better metric to compare with unimpaired flows than is face value, but the State Water Board has limited information on actual use. Comprehensive review and synthesis of the State Water Board's paper files would, however, provide only a crude estimate of actual historic and current use because of gaps in reporting an unreliability of the data already collected. Finally, there is a linkage between water availability in many surface areas and groundwater pumping, but the State Water Board has no information on percolating groundwater pumping in the Delta watershed" (State Board memo to Delta Vision Blue Ribbon Task Force, 9-26-08, pp3-4).

Summarizing the situation in 2008, the Board staff stated:

> "Currently the State Water Board does not possess sufficient authority to effectively monitor and enforce water right laws and to meet its responsibilities. In particular, the law does not (1) provide clear authority for the State Water Board to require monitoring by diverters, (2) authorize monetary penalties for monitoring and reporting violations, (3) have adequate penalties for unauthorized diversions and violations of cease and desist orders, and (4) have provisions for interim relief. The ability to provide for interim relief during the pendency of an enforcement action is particularly important. Because of the complexity of water rights issues and the propensity of parties facing enforcement to pursue tactics that drag out the proceedings, such proceedings may take years. During this time, activities that damage other water users or the environment will continue without any requirement that the violator take steps to avoid or reduce the damage

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[14]The same would generally be true of other watersheds in California.

[15] This total does not account for pre-1914 appropriative rights or riparian rights. The memo does not discuss diversions elsewhere in the Central Valley or other parts of California. However, there is no reason to believe that the situation is generally different elsewhere in California with respect to small diverters. It should be noted that the quantity of water specified in an appropriative water right is the *maximum* diversion. It is therefore not surprising that the total quantity of permitted diversions may exceed the annual flow in a stream. However, when it greatly exceeds the maximum annual flow, this can become problematic. It gives rise to a phenomenon commonly referred to as "paper water" whereby water rights being transferred may cover water that had not actually been diverted by the seller. This can be avoided if there is careful monitoring of actual diversions, something that occurs in some other Western states, as described below, but not so far in California.

during that period. Appropriate enforcement and monitoring tools are increasingly important as California faces critical water supply shortages and conflicts between water diversions and public trust issues" (Memorandum from Dorothy Rice, Executive Director to John Kirlin, Executive Director, Delta Vision Blue Ribbon Task Force, June 2, 2008, pp. 5-6).

The limits to the Board's effectiveness arise partly because its Division of Water Rights has been "chronically underfunded" (Wilson 2011a, "Statements of Water Diversion and Use: Providing a Better Picture of Water Use in the Delta," undated but presented to the State Board on November 1, 2011, p.12). This, in turn, arises in part because of the historic opposition of water users in California to having their diversions closely observed.

The Board's candid observations to the Delta Vision Blue Ribbon Task Force in 2008 prompted the Task Force to call for action to "improve the compliance of diversions and water use with all applicable laws." The Task Force found that:

> "The State Board will require secure annual funding for additional positions to investigate water rights compliance, illegal diversions, waste, and unreasonable use. The State Board's capacity should be expanded to be able to:
>
> i. Require monitoring by all water diverters, including those within the Delta who are currently not required to report diversions
> ii. Authorize monetary penalties for monitoring and reporting violations
> iii. Create adequate penalties for unauthorized diversions and violations
> iv. Possess provisions for interim relief" Delta Vision Blue Ribbon Task Force, *Delta Vision Strategic Plan* October 2008, pp. 127-128.

These recommendations were endorsed by the Delta Vision Committee, which was comprised of the following state officials: the Secretary for Resources, the Secretary for Environmental Protection, the Secretary for Business, Transportation and Housing, the Secretary for Food and Agriculture, and the President of the California Public Utilities Commission. The Delta Vision Committee issued the Delta Vision Implementation Report, which recommended as follows: [16]

> "[A] The State Water Resources Control Board needs authority to collect and disseminate accurate information on all surface water diversions in the state. Consequently, all statutory exemptions from water diversion and use reporting should be repealed and enforcement authority extended, and a streamlined process implemented requiring complete, timely, and accurate information from all diverters...
>
> "[B] The Water Board needs authority to require interim remedies, after opportunity for hearing, to prevent irreparable harm to the environment and other water right holders,

[16] The Delta Vision Blue Ribbon Task Force was established by Governor Schwarzenegger's Executive Order S-17-06 in September 2006 and charged with developing both a long-term vision for the Delta and a plan to implement that vision. The Executive Order charged a Committee of the Governor's Cabinet Secretaries, the Delta Vision Committee, to review the completed work of the Task Force and to make their own implementation recommendations, set forth in the December 2008 Implementation Report.

> while underlying proceedings continue. Interim remedies could include requiring the diverter to take appropriate action to mitigate potential harm or to provide necessary information. As with courts, Water Board evidentiary proceedings can take many years. Unlike courts, however, the Water Board currently has no authority to issue interim orders designed to prevent irreparable harm.
>
> "[C] Further, the Water Board needs to clarify existing water rights in many parts of the State in light of poorly defined or unreported riparian and appropriative water right claims and the unquantified needs of fish and wildlife. The Board needs the authority to initiate stream adjudications and collect adjudication costs from the parties diverting water. This process will respect area of origin rights" (Delta Vision Committee Implementation Report, December 31, 2008, pp. 9-10 (numbering added).

Bills to implement these recommendations were introduced in the 2009 legislative session, but they met with opposition from water users. By the end of the regular legislative session there had been no progress on these and other bills connected with the Delta, and a special session was called in the fall specifically to consider legislation related to water issues. After several failed attempts, agreement was reached in the closing hours of that session on a package of five bills that were hastily enacted. One of those (SBX7-8) dealt with surface water rights and another (SBX7-6) with groundwater.[17] SBX7-8 essentially enacted the recommendations in item [A] above. It imposed penalties for failure to report diversions and it eliminated an exemption from the 1965 reporting requirement for water diverters in the Delta. It added funding to increase the number of state water rights enforcement personnel from 8 to 33 staff positions. But, provisions to implement items [B] and [C] were dropped in the final hours of closed-door negotiations between the governor and the two leaders of the legislature from each party, including stronger powers for the State Board to enforce water rights and crack down on illegal diversions and increased penalties.

The judgment of the newly appointed Delta Watermaster is that the Board lacks adequate funding to process the additional reports of water diversions that are being submitted under SBX7-8. "No funds are allocated for administration associated with the over 15,000 non-Delta statements or for acceptance and review of future Supplemental Statements. No other funding is currently provided for the Statements Program. To effectively administer the Statements Program, a permanent funding source must be obtained... Without a funding solution, vital information on the number of diverters and the amounts of diversions by water users will become unusable" (Wilson 2011a, p.12). He concluded that "[U]nless the lack of funding to implement the Statements Program is corrected, the ability of the State Water Board to effectively implement the program will be severely compromised. In addition, the new requirements regarding water diversion measurement must be implemented carefully to deal with the practical problems facing many diverters" (Wilson 2011a, p. 13).

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[17] Other bills addressed Delta governance, including establishing a Delta watermaster to be appointed by the State Board; authorized a bond to fund water projects (the bond requires voter approval and has not yet been placed on the ballot); and mandated increased water conservation.

In addition to requiring the reporting of diversions starting in July 2010, SBX7-8 required that, starting in January 2012, all diverters who file Statements of Water Diversion and Use measure the amount of water diverted using "the best available technologies and best professional practices" unless implementation is "not locally cost-effective." What this means and how it will be implemented has not been finally determined. The State Board has indicated that it may issue additional guidance for future reporting years once it has reviewed the 2012 measurement information (SWRCB 2011).

Because of the failure to grant powers to the Board to initiate stream adjudications on its own authority, to obtain interim relief, and to deal with unauthorized diversions, as well as the inadequate funding to process statements of diversion outside the Delta, there remains a great deal of uncertainty about exactly who is diverting water in California, and in what quantities.[18]

2.6 Groundwater Rights: The Rights of Overlying and Other Users to Groundwater

A different scheme applies to groundwater, which is water found below the ground. As with riparian rights, the legal scheme governing groundwater allowed the owner of land overlying groundwater to use groundwater was derived from common law. California divides groundwater into two categories, "percolating groundwater" and "subterranean streams," even though these terms are at odds with what is now known about hydrogeology and water's movement (Sax 2002, p.1).[19] "Subterranean streams" are those underground waters "…flowing through known and definite channels" (Water Code §1200). All other underground waters are considered to be "percolating groundwater."

Subterranean Streams

Subterranean streams are considered to be part of surface water and thus subject to the jurisdiction of the State Board (Water Code §1200).[20] As a result, the right to water from a

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[18] It is worth noting that there are a few areas outside the Delta where surface water diversions are closely monitored and seniority of appropriative water rights is effectively enforced. These occur in adjudicated streams administered by watermasters. In the Central Valley, a watermaster was created in 1927 for the Kings River following a lengthy adjudication process. In addition, DWR provides eight watermasters for several small streams in the northern part of California. The DWR watermaster program was initiated in 1924 "to provide for general public welfare and safety after many injuries and some deaths resulting from disputes over adjudicated water rights." http://www.water.ca.gov/watermaster/ [accessed 11-15-2011]

[19]"To put the matter as simply as possible, the above categories [surface water, percolating groundwater, and subterranean streams] do not accord with scientific understanding of the occurrence and distribution of water on and in the earth. To hydrogeologists, water is a continuum. The same water may sometimes be found on the surface of the earth and at other times underground. Water moves by the force of gravity, and whether it is surface water or groundwater at any particular moment depends on the slope (known as gradient) and direction of the medium through which it is moving at a given moment, on obstacles it encounters, and on the topography of the land. Moreover, from a technical perspective, the distinction between percolating groundwater and subterranean streams is meaningless, or nearly so." (Sax 2002, p.1)

[20] The State Board's Garrapata Creek Decision, listed the following physical conditions that must be present for groundwater to be classified as a subterranean stream: "(1) a subsurface channel must be present; (2) the channel must have relatively impermeable bed and banks; (3) the course of the channel

subterranean stream falls under the water rights schemes discussed above—appropriative rights and riparian rights.

Percolating Groundwater

Percolating groundwater (hereafter, the term "groundwater" is used to refer just to percolating groundwater) is largely unregulated by the State Board. There are over 20 different types of local water agencies (e.g., irrigation districts, county water districts, water conservation districts), and there may be as many as 2,300 of these agencies that have an interest in groundwater (Nelson 2011, pp. 6–7). In addition, there are many individual pumpers. The groundwater rights scheme for percolating groundwater borrows from both riparian and appropriative rights, although there is no state permitting system for groundwater (Littleworth and Garner, p. 70). Similar to riparian rights, "overlying" groundwater rights allow for the use of groundwater on land that overlies the groundwater basin (Littleworth and Garner, p. 70). An owner of land overlying a groundwater basin can just pump the water, and need not report the use (Sax 2003, p. 270). Overlying groundwater rights are "correlative," which means that owners may not pump to the detriment of their neighbors, and in times of insufficient supply, each landowner is entitled to "a fair and just proportion" of the basin's supply (*Katz v. Walkinshaw (1903)* 141 Cal. 116, 136). By comparison, "appropriative" groundwater rights allow for the use of percolating groundwater on land that is not overlying. Appropriative groundwater rights, however, only apply to "surplus water" (water that is not otherwise needed by overlying lands), and they are first in time, first in right *(City of Barstow v. Mojave Water Agency* (2000) 23 Cal. 4th 1224, 1241). Unlike the appropriative system that applies to surface water, however, there is no statutory permitting procedure for appropriating percolating groundwater (Littleworth and Garner, p. 75).

Groundwater Monitoring, Management, and Regulation

Despite the importance of groundwater in California, there is no monitoring of groundwater withdrawals by individual users, and an attempt to create that power was dropped from 2009 legislation.[21] California law does give local water agencies the ability to create and implement

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must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel." State Board Decision 1639, June 17, 1999, p. 4 (finding that water in the alluvium of the valley of Garrapata Creek is a subterranean stream).

[21]SBX7-6 "requires that elevation levels of groundwater basins—though not volumetric amounts of groundwater extracted—'be regularly and systematically monitored locally' and reported no later than January 1, 2012. While the legislation empowers a wide variety of local agencies and special districts to assume responsibility for monitoring and reporting elevations from individual groundwater basins, SBX7-6 directs the state Department of Water Resources (DWR) to perform the groundwater elevation monitoring function if no such local agency or special district volunteers to do so. The legislation does not, however, provide for any funding for DWR to perform monitoring. The bill also gives DWR the responsibility to collect, aggregate, and report the groundwater elevation monitoring data generated under the legislation, as part of DWR's ongoing water planning responsibilities. SBX7-6 specifies that individual property owners—such as groundwater pumpers—are not required by the legislation to compile or report groundwater monitoring information or to permit government officials to enter their property for the same purposes." (Frank 2010, p. 23). It is worth noting that on some streams in

groundwater management plans, but plans are not required, and if created, need not be implemented (Water Code §§10750-56). Counties can also adopt local groundwater management ordinances.[22] These local efforts, however, have typically been considered to be too limited to ensure that groundwater is effectively managed across the state (See, e.g., Sax 2003, p. 271). Groundwater rights can be protected by legal action—a lawsuit can be brought to "adjudicate" a basin. Given the time and costs associated with an adjudication – the 19 basin adjudications averaged 7 years in length, and the longest took 24 years (DWR 2003, p. 42–42 [Table 5])—this typically occurs when a basin is in crisis. The process of adjudication serves as a "safety valve" for basins in crisis, which may be part of the reason California never reformed the groundwater system (Sax 2003, p. 271).[23] When such a lawsuit is brought, the court determines the groundwater rights of each user, and appoints a watermaster who oversees the basin so that it is managed according to the court's decree (see, e.g., Littleworth and Garner, pp. 182–186). Of California's 515 groundwater basins and subbasins (DWR 2003, p. 106), only 22 have been adjudicated.[24] Adjudications address only water quantity, but the State Board may file suit to "prevent destruction of or irreparable injury to the quality of such [ground] water" (Water Code §2100).[25]

Of the total of 19 groundwater basins that have been adjudicated, all but one (the Scott River Stream System) are located in or south of Kern County (DWR 2003 [Bulletin 118], pp. 42–43). The first basin to be adjudicated was the Raymond Basin in the Pasadena area. After well water levels in that basin fell between 30 and 50 feet, the City of Pasadena brought suit against the City of Alhambra. After almost 20 years, the judge signed a judgment that adopted a stipulated agreement worked out among the parties. The agreement divided the safe yield proportionately among the parties, and a watermaster was appointed to manage the safe yield (DWR 2003 [Bulletin 118], p. 41). Many other basins in Southern California have been adjudicated.[26] By contrast, in much of the rest of the state groundwater basins have not been adjudicated, and groundwater extraction is governed, if at all, by local statutes. Partly in response to the 1991

California, surface water users actually divert river water by pumping from wells immediately adjacent to the river, thereby evading the (notional) regulation of their surface water diversions by the state board. Sax suggests that this may be a reason why surface water users have not advocated for groundwater reform because they may prefer that their use of groundwater remain unregulated (Sax 2003, p. 271).

[22] For an example of a Groundwater Management Model Ordinance, see DWR 2003, Appendix D, pp. 232 *et seq*.

[23] In addition to the DWR watermasters for some small Northern California streams mentioned in footnote 32, DWR serves as watermaster for two large groundwater basins in Southern California.

[24] DWR website. Court Adjudications. Last accessed October 18, 2011. www.water.ca.gov/groundwater/gwmanagement/court_adjudications.cfm,

[25] We are not aware of any such suits having been filed.

[26]See, e.g., "Southern District, Background," Department of Water Resources, http://www.water.ca.gov/watermaster/aboutwatermaster/index.cfm (accessed February 6, 2012).

drought water bank, 22 of California's 58 counties have adopted ordinances that restrict the direct export of groundwater (Hanak and Dyckman 2003, pp. 491–499). It is believed that these ordinances came about because many rural residents feared that water marketing would lead to the export of groundwater, and that local wells would be impacted as a result (Hanak and Dyckman 2003, p. 495).

One might ask why groundwater adjudication has been used quite successfully in Southern California to manage the scarce groundwater resources, but not elsewhere, especially most of the Central Valley. The explanation lies in the fact that the water users in the two areas are different, and their incentives are different. The groundwater adjudications in Southern California primarily involved urban water agencies that extracted groundwater. In the Central Valley, the groundwater users are primarily individual farmers. In some cases in Southern California, groundwater overdraft was causing salt-water intrusion that threatened to contaminate the aquifer unless remedial action was undertaken. In Southern California, the alternative to local groundwater was surface water imported from the Colorado River or from Northern California via the State Water Project. The imported water was expensive, and there was relatively little disparity in the cost of this alternative among the various groundwater users in Southern California. In that situation, there was a strong incentive to agree on measures to conserve the use of groundwater, and the re-distributional consequences of such agreement were relatively moderate. In the Central Valley, by contrast, surface water supplied to agricultural users is relatively inexpensive, partly because some of the sources are nearby and partly because of the subsidy to agricultural users served by the Central Valley Project in the form of foregone interest. Moreover, because of the variation in access to surface water and in the depth to groundwater in different parts of the Central Valley, there could be pronounced redistributional consequences if groundwater were adjudicated.[27] These factors diminish the likelihood of successful political or legal action to locally control groundwater extraction in the Central Valley.

2.7 Contractual Water Rights: Rights Obtained by Contract from the Central Valley Project and State Water Project

Many water users obtain water by contract though the federal Central Valley Project (CVP) and the State Water Project (SWP).

The Central Valley Project

The CVP is the state's largest water supplier, and water from the CVP may be used for river regulation, improvement of navigation, flood control, irrigation, domestic uses, power production, recreation, fish and wildlife enhancement, and water quality improvements (Littleworth and Garner, pp. 21–22). On average, the CVP delivers about 7 million acre-feet of

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[27] For a further discussion, see Timothy H. Quinn, *A More General Theory of Environmental Policy With an Application to the Evolution of Groundwater Law in California.* Ph.D dissertation, Department of Economics, UCLA. Issued as Report P-7048 by the Rand Corporation, December 1984; also, Nathan Hampton. *Groundwater Management in California: Rent-seeking Behavior under the Correlative Rights Doctrine*. Ph.D dissertation Department of Economics, UC Santa Barbara, June 1989.

water, of which about 85 percent is for agricultural production, with about 15 percent for urban and industrial uses (Littleworth and Garner, p. 23). Central Valley Project water is used to irrigate more than 3 million acres of farmland, and to provide drinking water to about 2 million people (DWR, http://www.water.ca.gov/swp/cvp.cfm, accessed February 20, 2012). Many of the original CVP water contracts were signed in the middle of the last century, with a term of 40 years.[28] They expired in the early 1990s. At that time, the term of the contracts was reduced from the original 40 years to a term of 25 years, with future renewals at the discretion of the U.S. Secretary of the Interior.[29] The Central Valley Improvement Act, passed in 1992, added to the purposes of the CPV environmental uses such as environmental protection, restoration and enhancement, and protection of the Bay-Delta.[30]

The State Water Project

The SWP was approved by the voters in 1960.The first contract, with The Metropolitan Water District of Southern California, was signed later that same year and served as a model for subsequent contracts. Collectively, the contracts are for about 4.2 million acre-feet per year, although for the period from 1996 to 2006 (the ten years preceding the latest DWR Bulletin on management of the SWP) the average conveyance was just 2.9 million acre-feet per year (DWR 2008b, pp. xxxvii, 150).[31] The term of the contracts is for the longest of the following: "the project repayment period, which extends to the year 2035; 75 years from the date of the contract; or the period ending with the latest maturity date of any bond used to finance the construction costs of project facilities" (DWR 2008b, p. 10). There are 29 agencies and districts that have long-term contracts with the State Water Project (DWR 2008b, p. 149). The State Water Project provides drinking water to about 20 million Californians, and provides irrigation water to about 600,000 acres of California farmlands.[32] Both the CVP and the SWP may in principle be able to adapt to

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[28] Bureau of Reclamation. Central Valley Project Improvement Act (CVPIA). http://www.usbr.gov/mp/cvpia/index.html, accessed November 18, 2011.

[29] Bureau of Reclamation. Central Valley Project Improvement Act (CVPIA). http://www.usbr.gov/mp/cvpia/index.html, accessed November 18, 2011.

[30] Public Law 102-575, §3402(a) states: The purposes of this title shall be: (a) To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley…; (b) To address impacts of the Central Valley Project on fish, wildlife and associated habitats; … (e) To contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; (f) To achieve a reasonable balance among competing demands for use of Central Valley Project water, including the requirements of fish and wildlife, agricultural, municipal and industrial and power contractors.

[31] While the SWP had originally contracted to supply 4.2 million acre-feet, with the California voters' rejection of the Peripheral Canal in 1982 its delivery capacity was severely restricted. Before the Coordinated Operation Agreement was signed with the CVP in 1986, the SWP delivery capacity was limited to about 2.4 million acre-feet.

[32] DWR website. California Geography and Its Water Needs. www.water.ca.gov/swp/geography.cfm (accessed 12/12/2011).

changes in the availability of surface water supplies more easily than the appropriative rights system since they have the ability to rewrite the contracts when they expire, or can even amend the contracts before expiration. Moreover, the contracts contain provisions allowing curtailment during droughts. That said, as is often the case with California water, there is likely to be a great deal of political resistance to modifying the terms of the contracts.

2.8 Other Statutes and Requirements That Impact Water Availability and Discharges

A number of other statutes and requirements further complicate California's water system. For example, if water temperature and salinity levels change, the Federal and State Endangered Species Acts may require that more water be provided for environmental purposes. Changes to water quality could result in violations of water quality standards contained in the Federal Clean Water Act and California's Porter-Cologne Water Quality Control Act. These violations may lead to restrictions on discharges by individuals, agricultural interests, or municipalities. National Pollutant Discharge Elimination System permits contain water-quality based effluent limitations to protect water quality. If the quality of receiving waters deteriorates, permit conditions will need to take that deterioration into account. Other users of water from the Colorado River may press for California to reduce diversions, and to live within its allotment if shortages continue (Littleworth and Garner, p. 3). Together, these constraints may argue for taking early action rather than waiting until California's options become more limited.

2.9 What Happens in a Time of Shortage?

How does the allocation of water in California respond in practice when there is a drought? The answer is different for each of the legal regimes described above. The following discussion first discusses the legal constraints, and then briefly mentions what happened during two recent droughts.

Surface Water Users May Increase Groundwater Use with Few Consequences

Since many water users in California have some access to groundwater as well as surface water, those users typically respond to a reduction in surface water availability by increasing their pumping of groundwater, causing at least a temporary over-extraction of groundwater and a decline in water tables. Since the extraction of groundwater is largely unregulated by the State Board, there is no state-level administrative mechanism to manage groundwater extraction in California during times of drought. As noted above, overlying groundwater rights are correlative, and overlying landowners are entitled to "a fair and just proportion" of the basin's safe yield. At times of surface water shortage, groundwater extractions are almost certain to exceed the safe yield. The only mechanism by which the correlative right could be enforced is if an overlying landowner were to file a suit against other overlying landowners for extraction in excess of their "fair and just proportion." Such a lawsuit is likely to be costly and time consuming.[33] It is unlikely to offer any immediate relief.

Riparian Users Are Limited to Legal Action

The situation is somewhat similar in the case of riparian rights to surface water. As noted above, riparian rights are correlative and all riparian users are required to reduce their diversion at times of low flow. But there exists no administrative mechanism by which that obligation is enforced. Instead, a riparian diverter would have to file a suit against other riparian diverters to reduce their diversions. Such litigation is unlikely to be inexpensive or to offer any immediate relief. The plaintiff would have to provide expert testimony about the extent of the drawdown and would have to establish what level would be reasonable to the satisfaction of a court.

Unless Their Rights Are Subject to Certain Permit Terms, Appropriative Users Are Limited to Legal Action

In the case of appropriative rights, basically, the only administrative activity to enforce seniority in California is that action taken pursuant to a Water Right Permit Term. The most prominent of these is Standard Water Right Permit Term 80. Starting in 1965, over 500 permits for appropriative water rights in the Sacramento-San Joaquin Delta contained Permit Term 80 under which "… the Board reserved jurisdiction to change the season of diversion when water availability becomes known with greater certainty" (State Board Water Right Decision 1594 (1983) p. 1). In the 1980s, the State Board exercised that jurisdiction, and applied to those permits a restriction that "…requires permittees to cease diverting water any time that natural flow is insufficient to meet Delta Water quality standards," that is, when either the Central Valley Project or the State Water Project (collectively, "Project") is releasing stored Project water "…to meet Delta water quality standards or other in basin demands." State Board Water Right Decision 1594 (1983) pp. 8, 33–35. A court subsequently upheld the restriction (*Phelps v. State Water Resources Control Board*, (2007) 157 Cal. App. 4th 89, pp. 96-97 (upholding the imposition of civil penalties against Delta water users who failed to curtain their water use when supplemental water was being released by the Central Valley Project and State Water Project)). There are several other permit terms that either reserve jurisdiction or limit the season of diversion. None of these apply to appropriative rights acquired prior to 1965, and many have jurisdiction limits. Otherwise, an individual appropriator would need to file a lawsuit against upstream appropriators to force them to cease their diversions if they were junior to him. Again, this is typically unlikely to occur as it would be expensive and would be unlikely to afford any immediate relief.[34]

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[33] Although an individual with an entitlement to water could seek an injunction in order to get more timely relief, that individual would need to meet the statutory standards, showing in the complaint "that the plaintiff is entitle to the relief demanded…" This is likely to be difficult to establish in the case of surface water, where there are often many different individuals with either an actual or a potential right to the water from the same stream. California Code of Civil Procedure, Section 526(a)(1).

[34] "A private suit for determining title to water binds only those who are parties to the suit. It may later be nullified by the assertion of a legitimate claim by a water user on the stream who was not a party to the suit. Moreover, private suits are inadequate because shortages in supply, new appropriations, or new

Important exceptions to the above are those few streams in California that have been adjudicated and for which a watermaster has been created. In those cases, the watermaster rigorously monitors diversions and enforces seniority. If necessary in a time of shortage, the watermaster would shut down unauthorized diversions by junior appropriators.

Contractual Rights Holders

The situation is rather different for users who receive water through a contract with the federal and state water projects. Those projects have policies to curtail the delivery of water in times of shortage and they regularly exercise this right. In 1991, for example, the CVP restricted deliveries to water supply contractors to 25 percent of their contract amount. For water settlement/exchange contractors—users who had pre-existing water rights along the Sacramento and San Joaquin Rivers (mainly riparian rights) and agreed to forebear from exercising their diversion rights in exchange for free water from the CVP—their deliveries were reduced to 75 percent of the contract amount. Similarly, in 1991 the SWP gave no deliveries to agricultural contractors and reduced deliveries to urban users by 75 percent.

Regulators and Water Users Have Responded to Past Droughts with Market Transfers

When droughts have occurred in California in the recent past (1976–1978, 1987–1992 and 2007–2009), regulators and water users relied on water transfers as the main adaptive response. As discussed in more detail later in the paper, during the 1991–1992 drought regulators used creative legal arguments to facilitate water transfers from agricultural users to urban users. More recently, the DWR established the 2009 drought water bank to facilitate water transfers, again from agricultural users to urban users. This suggests that adaptation to drought will likely involve market transfers, although the precise mechanism by which that would occur is unclear.

2.10 California Compared to Other Western States: Wyoming Example

As Dan Tarlock has noted, "California water rights do not resemble water rights elsewhere in the West" (Tarlock 1994, p. 75). Other Western states started out with the same system of administering appropriative surface water rights, in which the state government played only a modest role in administering appropriative water rights, priority was established simply by posting a notice of appropriation with the County Recorder, and disputes over water rights were resolved largely through litigation in state courts. However, to an extent greater than in California, many other Western states subsequently deviated from this model and tightened up the administration of surface water rights. By mid-century major streams in many other states had been adjudicated, and there was some administrative apparatus to monitor diversions and enforce seniority. Wyoming, for example, divided the state in 1890 into four water divisions corresponding to the various drainages in the state and charged the superintendent of each

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riparian uses have the potential for bringing all water users on the stream in conflict."[In re *Waters of Long Valley Creek Stream System* (1979) 25 Cal. 3d 339, 347, 356, 158 Cal. Rptr. 350, 599 P.2d 656] division with monitoring diversions and enforcing priority within the division. Moreover, in the 1920s, Wyoming took steps to quantify water rights, so that by 1922, all rights acquired before statehood in 1890 were quantified (Squillace 1989).[35] Wyoming also adopted a standardized formula for appropriative rights for irrigation use involving the allocation of a uniform quantum of water per 70 acres of irrigated land.

By contrast, although California adopted a version of the Wyoming system of water rights administration in 1913, it excluded riparian, and pre-1914 appropriative rights from that system, thereby creating the current patchwork quilt system of surface water rights. Moreover, many water rights in California have never been quantified, apart from those in adjudicated streams and basins. California water rights are distinctive in that they ". . . do not function to allocate water, but as licenses to take until the taking is contested" (Tarlock 1994, p. 75). "California appropriative and riparian water rights are more like unquantified licenses to receive large blocks of stored water or to capture natural flows or groundwater" (Tarlock 1994, p. 76). In addition, "…the state has never asserted effective management over the state's water users as opposed to storage and distribution" (Tarlock 1994, p. 75). With the exception of a few scattered watermasters (e.g., the Delta watermaster, the watermasters for a number of streams in northern California, and the watermasters for groundwater in Southern California) California lacks a local administrative apparatus like that established in Wyoming to monitor diversions and enforce seniority.

Given the importance of water to California, and the historic lack of regulation in this state, changes to water rights and the administration of those rights has been and will continue to be politically contentious.[36] This system may have been able to withstand reform efforts thus far partly because "[s]trong local institutions control large blocks of water with substantial margins of safety so that there is seldom a need to stand on water rights as there is in Colorado, for example" (Tarlock 1994, p. 76). Serious long-term droughts may change that, however, and may lead to protracted controversies and possible litigation among water users over their rights. The current system that functioned, although with some difficulty, during a period of stability, may not be able to cope with the stress of long-term changes in water availability. For these reasons, the changes in water supply expected to occur with the advent of climate change may create conditions similar to those that led to changes in water laws in other Western states.

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[35]Wyoming also does not have riparian rights. In 1896, the Wyoming Supreme Court found that the system of riparian rights "is unsuited to our requirements and necessities, and never obtained in Wyoming" (Trelease and Lee 1966, p. 7).

[36] See, e.g., Weigand, S., "Water Package: Sealing the Deal." *Sacramento Bee,* December 11, 2009.

Section 3: The Likely Impact of Climate Change on California's Water Sector

Climate change will impact both the available supply of water and the demand for water in California. Although the precise future impacts are not yet known, some changes have already occurred, and others are projected to occur.

3.1 Physical Changes to Water Supply, Demand, and Storage

Climate change is projected to affect California in a number of ways. Following is a brief summary of the physical changes expected to occur. Given both the uncertainty in climate responses to increased greenhouse gases and the variability among models, results from several models were considered where possible.

The Amount of Water Stored in the Sierra Snowpack Will Decrease

California currently relies on snowpack in the Sierras for about one-third of its major storage. Water in the Sierra snowpack is released slowly, between April and July (DWR 2008a, p. 4). During the twentieth century, the average early spring snowpack in the Sierra Nevada decreased by about 10 percent (DWR 2008a, p. 3). Climate change will result in further reduced natural storage in the Sierra snowpack for two reasons: higher winter temperatures are expected to increase the amount of precipitation falling as water and decrease the amount falling as snow, and the snow that does fall is expected to melt earlier in the spring. Compared to the reference period 1961 to 1990, April 1 snowpack for the period 2020 to 2049 is estimated to be reduced by 26 percent under a lower emissions scenario and to be reduced by 60 percent under a higher emissions scenario (Hayhoe et al. 2004, Table 1). Without major investments in infrastructure, flood risks in the winter and spring will increase, while available water in the summer will sharply decline. April 1snowpack for the period 2070 to 2099 is estimated to be reduced by 72 percent under a lower emissions scenario and to be reduced by 89 percent under a higher emissions scenario (Hayhoe et al. 2004, Table 1).

Streamflows Will Occur Earlier Than Under Historic Conditions

Over the last century, California's temperature increased by one degree Fahrenheit, mostly at night and in winter. The biggest changes occurred at high elevations (DWR 2008a, p. 3). These increases in temperature are projected to continue (Hayhoe et al. 2004, Table 1), which will cause the snowpack to melt earlier in the year, and will cause a shift in precipitation so that more falls as rain than snow, compared with existing conditions (Hayhoe et al. 2004, p. 5). As a result, the timing of streamflows will shift so that they occur earlier in the year and end earlier in the summer than they did in the recent past (1961 to 1990) (Hayhoe et al. 2004, Table 1). In addition, peak flows, which have increased on many rivers over the past 50 years, may continue to increase and are expected to occur earlier in the spring (DWR 2008a, p. 3).[37]

[37] The typical irrigation season for which appropriate water rights are acquired starts around March. With climate change, some of the streamflow on which existing rights draw will shift into February.

Changes in the timing of flows create practical problems for water users, but may also have legal impacts. Existing appropriative water rights are specific to a particular time period for withdrawal. The availability of additional streamflows during other time periods (for example February or March) will not benefit those users unless they obtain new (and necessarily junior) water rights for those periods, or unless there is a shift in the timing of existing water rights.

The Effective Surface Water Supply Will Be Reduced

Climate change is expected to reduce spring and summer surface water supplies. Even if precipitation remains unchanged from current conditions, however, projected increases in air temperatures will effectively reduce surface water supply. For a given amount of precipitation, increased temperatures will increase transpiration by terrestrial vegetation and evaporation from surfaces including surface water bodies. As a result, runoff will decrease, evaporation from streamflows will increase, and thus stream flows will decrease. Compared to the reference period 1961 to 1990, reservoir inflows during the spring and early summer (April to June) for the period 2020 to 2049 are estimated to be reduced by between 11 percent and 20 percent under a lower emissions scenario, and to be reduced by between 19 percent and 24 percent under a higher emissions scenario (Hayhoe et al. 2004, Table 1).[38] For the period 2070 to 2099, reservoir inflows during the spring and early summer (April to June) are estimated to be reduced by between 1 percent and 41 percent under a lower emissions scenario and to be reduced by between 46 percent and 54 percent under a higher emissions scenario (Hayhoe et al. 2004, Table 1).

There Will Be Increased Variability in California's Surface Water Supply

Surface water supplies will be more variable and less reliable, thus likely prompting an increase in the use of groundwater and other stored surface water. For example, in the Sacramento Valley, for the period 2070–2099, about 50 percent of the time there will be almost no change in the amount of surface water available to agricultural users, while in the driest 15 percent of years there will be an average reduction of 53 percent (Hanemann et al. 2006, p. 7). The situation is projected to be more severe in the San Joaquin Valley over the same period. There, about 50 percent of the time there will be a reduction of about 10 percent in the amount of surface water available to agricultural users (Hanemann et al. 2006, p. 7). In the next driest 35 percent of years there will be an average reduction of 48 percent, and in the driest 15 percent of years there will be an average reduction of 68 percent (Hanemann et al. 2006, p. 7). These reductions will have a significant negative impact on net revenue attributed to Central Valley agriculture, with estimated reductions of between 8 percent and 14 percent under one scenario (Hanemann et al. 2006, p. 1). Urban areas will also be negatively impacted, with costs to urban users in the South Coast estimated under one scenario to be between $1 billion and $2 billion dollars per year (Hanemann et al. 2006, p. 1).

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[38] The reservoirs studied were Shasta, Oroville, and Folsom in the Northern Sierra, and New Melones, New Don Pedro, Lake McClure, and Pine Flat in the Southern Sierra.

Droughts Will Occur More Frequently and Will Be More Extreme

Climate change will increase the number of dry years and decrease the number of wet years. For the period 1922 to 1994, 48 percent of the years were wet (above normal rainfall for the period), and 52 percent were dry (below normal, dry or critically dry) (Vicuña 2005, Table 1). Under one scenario, for the period 2070 to 2099, the percent of above normal or wet years falls dramatically, to just 22 percent, while the percent of below normal, dry, or critically dry years is projected to increased to 78 percent (Vicuña 2005, Table 1).[39] This will increase the likelihood of consecutive dry years, thus droughts will become longer and more severe. Both urban and agricultural users will face reduced deliveries of water.

Increased Water Temperatures Will Adversely Affect Fish Habitat

Taken together, increased temperatures and reduced streamflows will result in warmer streams. Salmonid and other species are sensitive to warmer temperatures and reduced flows, thus would be adversely affected by climate change. One analysis concluded that the long-term survival of spring-run Chinook salmon is questionable in the face of climate change, but noted that "water management adaptation may extend the survival of threatened salmon population on the time scale of decades" (Thompson et al. 2011, p. 5). Water management adaptation measures, which can be required by laws establishing water quality standards and protections for endangered species, may include the maintenance of minimum stream flows, thus leaving less water available for other users.

Increased Sea Levels Will Increase the Potential for Sea Water Intrusion in the Delta and Coastal Aquifers

Seawater expands as it warms, and this will result in sea-level rise. In addition, water will be added to the world's oceans as a result of melting glaciers and ice sheets. Over the past several decades, sea level along the California coast has increased at a rate of about 17 to 20 centimeters (6.7 to 7.9 inches) per century, which averages out to approximately 2 centimeters (3/4 inch) per decade. Further increases are projected. Using California sea level in the year 2000 as a baseline, projections of sea level rise in 2050 range from 30 to 45 centimeters (11.8 to 17.7 inches), and projections of sea level rise in 2100 range from 0.5 to 1.4 meters (19.7 to 55.1 inches) (Cayan et al. 2009). Increased sea levels will increase the frequency and severity of high sea level events. Increased sea levels will also increase the likelihood of saltwater intrusion into the Sacramento Delta, and also into coastal aquifers. Water users that rely on those sources will need to take steps to adapt to changes in water availability.

3.2 Human Responses That Will Further Impact Water Supply, Demand and Storage

Climate change is projected to affect California in a number of ways. Following is a brief summary of the changes influenced by human activity.

[39] Scenario GFDLA2.

Current Conflicts over Surface Water Diversions Are Likely to Be Exacerbated

As the demand for water increases and the supply decreases, conflicts over surface water diversions are expected to increase beyond those that currently exist. Late spring and summer streamflows will be diminished, rendering streams over-appropriated for that time period.

Groundwater Extraction Will Increase to Compensate for Diminished Streamflows

Historically, groundwater use increases in dry years, and decreases in wet years. During average years, groundwater accounts for 35 percent of the water used in California's urban areas, agricultural areas, and managed wetlands. That percentage jumps to 40 percent or higher under drought conditions, but some areas rely on groundwater for as much as 60 percent or more of their water supply (DWR 2009, Vol. 2, p. 8–10). California's Central Coast relies on groundwater for more than 80 percent of the area's urban and agricultural water use (DWR 2003). With climate change, droughts in California are expected to become more frequent, longer, and more severe. As a result, demand for and pumping of groundwater is expected to increase. Moreover, if the demand for surface water increases, the cost will likely increase, which will likely cause current surface water users to shift to less-regulated groundwater (Enion 2011, p. 2).

The Demand of Water for Outdoor and Irrigation Uses Will Increase

Compounding the problems of increased dry years is the projected increase in temperature, which will increase demand for water. Increased temperatures will result in increased evapotranspiration by plants, and a longer growing season (DWR 2008a, p. 5). As a result, the water needed for crops and other plants will increase. These effects are combined with, and will exacerbate, the effects of population growth on urban water demand.

The Demand for Storage Will Increase to Compensate for Decreased Streamflows

In California, changes in winter precipitation are far less significant economically than changes in temperature. Water is not a scarce resource in the winter; it is in spring and summer when water is scarce. Warmer winter temperatures will result in a decreased Sierra snowpack, and warmer spring temperatures will advance the timing of the spring snowmelt, thereby directly affecting spring and summer water supply. To compensate, and to make winter precipitation an economically valuable asset, investment in some form of storage will be required, which is a cost of climate change.

Water Marketing Will Help, but Is Not Enough

Although water marketing has progressed in California and is playing an increasing role in helping agricultural and urban agencies cope with variability, water marketing is severely constrained. The overwhelming majority of water market transactions are short-term leases (for one year or less) rather than long-term leases or permanent transfers of ownership. Short-term leases are hardly a viable basis for the adaptations that are needed to accommodate population growth and climate change impacts. Long-term transactions are constrained by the costs associated with environmental review, and by the fact that many smaller users' water rights are essentially unquantified, which is an impediment to long-term leases or permanent sales. The existing system, which does not require that rights be clearly established in most cases, is a significant obstacle to a more vigorous water market involving long-run or permanent transfers.

In discussions of water marketing as an adaptive response to water shortage, the Drought Water Bank established by DWR during the 1991–1992 California drought is frequently cited as a shining example.[40] Following three previous water years designated as "critical" and one that was designated as "dry," the winter of 1990–1991 was turning out to be another critical water year in California. In February 1991, the storage in the state's 155 largest reservoirs was only 54 percent of average, the lowest level since the 1977, a record dry year. Not since the 1928–1934 drought had there been such a prolonged dry period in the modern history of California. The CVP had announced that urban and agricultural users would receive only 25 percent of normal contract supplies (Settlement and Exchange contractor would be limited to 75 percent of their contract entitlements), and the SWP had announced that agricultural users would receive *no* supplies, while urban users would receive only 10 percent of their normal contract supplies. Responding to this crisis, the governor created a Drought Action Team which, on February 15, recommended the creation of a "Water Bank" through which DWR itself would buy water for resale to other users. The DWR set the purchase price at $125 per acre-foot. To cover administrative costs plus outflow requirements to move the water through the Delta, the sale price was set at $175 per acre-foot. The Water Bank entered into 351 contracts for the purchase of 821,045 acre-feet of water. By April 1, 18 water agencies had identified themselves to the Bank as potential purchasers. Twelve of these ultimately entered into contracts to purchase 389,970 acre-feet from the Bank. According to Gray (2008, p. 56), "[b]y virtually all accounts, the 1991 Water Bank was a success." Quoting DWR (1992, p.19), Gray writes: "because of the existence of the Water Bank, the implementation of 'stringent conservation practices, plentiful March rains, and a mild summer, conditions that could have been disastrous in some areas were made bearable.'" (Gray 2008). Within 100 days, a large-scale water transfer program had materialized from nowhere and was implemented with great resourcefulness and widespread cooperation.

Of the 821,045 acre-feet of water acquired by the Water Bank in 1991, about 50 percent was purchased through "fallowing contracts" in which the sellers were paid to fallow land that they would otherwise have irrigated. Another 33 percent of the water was purchased through "groundwater replacement" contracts under which the sellers agreed to pump groundwater to irrigate crops, allowing the surface water they would normally have used to be transferred to the Water Bank. The remaining 17 percent of water purchased was water in storage in a Sacramento Valley reservoir operated by the Yuba County Water Agency mainly for hydropower generation and flood control. The Water Bank also operated in 1992, when it acquired 193,193 acre-feet of water, and in 1994 when it acquired 222,000 acre-feet. Of the water acquired in 1992, 16 percent was from stored water, and the remainder was from groundwater replacement.

[40] For example, IPCC Working Group II (2001, p. 777–778)

Less well known are the unusual legal arrangements under which the Water Bank acquired its water. Gray remarks on the "rather startling situation" that although the State Water Resources Control Board is the principal regulator of surface water use in California, only two of the 351 contracts to sell water to the Bank in 1991 were subject to the Board's jurisdiction.[41]

This came about in several ways. First, in 1991 the Water Bank purchased 76,730 acre-feet from water users located along the Sacramento River. Many of those users received water from the CVP as *settlement* contractors. As Gray explains, "Because these contractors held riparian and pre-1914 appropriative rights that predated the construction of the CVP, their contracts with the Bureau recognize their pre-project rights as "base supply." The Bureau of Reclamation allowed the CVP water rights settlement contractors to transfer their base supplies to the 1991 Water Bank. In acquiring this water, DWR determined that the water rights settlement contractors' base supplies are legally equivalent to the riparian and pre-1914appropriative rights that the contractor held before the CVP was constructed. Based on this legal characterization of the CVP base supplies, DWR argued that the transfers were exempt from the Board's jurisdiction because the transfers involved riparian and pre-1914 appropriative rights, rather than water held by the Bureau under permits issued by the Board." Gray's assessment, however, is that: "These transfers should have been subject to the Board's jurisdiction, because the transfers (1) altered the riparian and pre-1914 appropriative rights of the CVP water rights settlement contractors and (2) changed both the point of diversion and place of use set forth in the Bureau's permits The Board did not assert jurisdiction over transfers of CVP water to the Water Bank, however, because it failed to focus on these legal issues at the time it approved the CVP transfers." (Gray 2008, p. 64–65).[42]

Settlement contractor and other water purchased by the Water Bank in 1991, amounting to about 50 percent of the water purchased, was water held under riparian rights. How was this accomplished, given that riparian rights are not an entitlement to any specific quantity of water and water acquired under a riparian right cannot be applied on non-riparian land and on land

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[41] The two contracts were for releases from storage from the Yuba County reservoir and for a purchase from one particular irrigation district.

[42]Gray notes that the Board does *not* accept that the CVP base supplies are necessarily tantamount to the pre-project riparian and pre-1914 appropriative rights of the Sacramento River settlement contractors. His own assessment is that "as administered during the 1991 Water Bank, the transfer of the CVP base supplies necessarily implicated the Bureau's water rights permits for the CVP and therefore should have been subject to the jurisdiction of the Board" (Id. at p. 75). The Board did not object to DWR's interpretation of CVP settlement contracts at the time because it was under pressure from the governor not to make trouble and its legal staff was not asked to evaluate the CVP transfers. "For the future, however, both the Executive Director and the Assistant Chief Counsel agree that the Board will assert its jurisdiction over those transfers of CVP base supplies that exceed the scope of the transferors' pre-project water rights and which require a change in the points of diversion, places of use, or purposes of use set forth in the Bureau's water rights permits for the CVP"(Id at p. 75).

not within the watershed of origin? (Gray 2008, p. 67).[43] In the case of sales by settlement contractors who had previously held riparian rights, the Bureau of Reclamation's determination of base supply effectively served as a quantification of the amount of water they held. With regard to the use of water on non-riparian lands, Gray's assessment is that DWR was able to overcome this legal obstacle "in a creative and convincing way" by virtue of the fact that, while it operated the Water Bank, it was also the operator of the SWP. "According to DWR, the riparians who sold to the Bank did not transfer water, because to do so would violate the proscriptions of non-riparian and out-of-watershed use. Rather, the riparians simply agreed not to divert the water that they normally would have used, which left that water in the Sacramento River and Delta channels unclaimed by any water rights holder. The DWR then took advantage of the unused water for the purpose of meeting its obligations to maintain Delta water quality… In other words, the Water Bank did not purchase *water* from the riparian. Rather, DWR acquired the *benefits of water* left in stream by the participating riparians' decision to forego the exercise of their riparian rights." (Gray 2008, p. 67–68).[44]

In the case of water purchased by the Water Bank through groundwater replacement contracts, [o]n the basis of this substitution of supply sources, DWR characterized these transfers as sales of groundwater, rather than surface water. As such, the transfers were outside the Board's jurisdiction." (Gray 2008, p. 65). However, Gray identifies an inconsistency in DWR's treatment of these transfers. He notes that "under DWR's theory, transfers of *surface water* (which the transferors replaced through increased pumping of groundwater) were treated for legal purposes as though they were transfers of *groundwater*."(Gray 2008, p. 76). If they were groundwater, however, they would be subject to the section 1220 of the Water Code, the "Protected Areas" legislation enacted in 1984, which specifies that "[n]o groundwater shall be pumped for export from within the combined Sacramento and Delta-Central Sierra Basins … unless the pumping is in compliance with a groundwater management plan that is adopted ... by the county board of supervisors … and that is subsequently approved by a vote in the counties or portions of counties that overlie the groundwater basin." [45] Gray comments that, "All of the 'groundwater' transfers to the 1991 Water Bank involved water from the Sacramento Basin as defined by section 1220. Thus, the statute would appear clearly to have been applicable to such transfers. Nonetheless, the Department of Water Resources determined that the law did not apply because, *for purposes of section* 1220, the transfers were of surface water, not groundwater. Thus, to avoid the Board's jurisdiction under the water transfer laws, DWR

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[43] "[A]ll of the water held pursuant to riparian right that was sold to the Water Bank was transferred out of the Sacramento River and Delta watersheds to the South Bay, to the San Joaquin Valley, and to southern California."

[44] At the time, a number of economists criticized DWR's creation of a Water Bank as unwanted government intervention into the market place. They argued that DWR should not have set prices or otherwise interjected itself in transactions between a willing seller and a willing buyer. But, without DWR's involvement, riparian water rights would have remained off the market.

[45] Cal. Water Code ¶1220(a) (West Supp. 1994)

defined the groundwater replacement transfers as 'groundwater transfers.' Yet, to circumvent the application of section 1220, the Department characterized the same transfers as 'surface water transfers.' " (Gray 2008, p. 77).[46]

In the 1992 Water Bank, as noted earlier, 84 percent of the water purchased was through groundwater replacement contracts. By then the legal situation had changed. In 1992, a law had been enacted (AB 2897) that gave permanent statutory authority for the Water Bank. In the case of groundwater replacement contracts, the law prohibits water users from replacing transferred surface water with groundwater unless the groundwater use is either of the following:(a) Consistent with a groundwater management plan adopted pursuant to state law for the affected area, or (b) Approved by the water supplier from whose service area the water is to be transferred and that water supplier, if a groundwater management plan has not been adopted, determines that the transfer will not create, or contribute to, conditions of long-term overdraft in the affected groundwater basin.[47] Presumably, the groundwater replacement contracts were authorized under part (b).[48]

In June 2008, following two critically dry winters, the governor issued a declaration of a statewide drought and proclamation of emergencies related to the drought in nine counties. That fall, DWR established a 2009 Drought Water Bank. As of May 2009, the Bank had transferred 81,275 acre-feet. If this, 58,047 acre-feet (71 percent) was water obtained through groundwater substitution; the remainder was acquired through fallowing contracts in the Sacramento Valley.

Four conclusions emerge from this history. First, in times of crisis state agencies are willing to do whatever it takes to make things work, even if that involves some far-fetched legal interpretations. Second, while the Water Bank purchases were useful adaptations to a situation

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[46]Gray notes: "The Board did not assert jurisdiction over the groundwater replacement transfers because it simply did not see the legal question presented by DWR's characterization of the transfers. … Indeed, as with the CVP base supply transfers, this omission may have been the result of the absence of attorney participation in the Board's informal review of the groundwater replacement contracts." (Id at p. 78).

[47] California Water Code 1745.10

[48] This provision seems somewhat questionable. Why should a supplier of surface water be the one to certify that the transfer will not contribute to overdraft in the affected groundwater basin? More important, since groundwater is a stock resource, the withdrawal of any quantum of groundwater at a particular point in time permanently depletes the stock of groundwater existing at future times. While extraction of groundwater now does not by definition contribute to a future extraction of groundwater, it *does* contribute to a future *lowering of the water table* compared to what that would have been in the absence of the current extraction. The reference to long-term overdraft, rather than to long-term lowering of the water table, evades this issue. A bill (AB 2776) was introduced in 2010 which prohibited a water user from replacing transferred surface water with groundwater unless the groundwater basin is being monitored consistent with existing law; it also prohibited water transfers from agricultural use to an urban use lasting longer than twenty years unless an evaluation is performed of the economic, social and environmental impacts on the area from which the water is transferred. The bill failed passage.

of shortage, they were essentially short-run in nature. There is no evidence, for example, that sellers would have been willing to fallow their land for multiple years in a row. While the State Board explicitly reviewed and approved the transfers that fell under its authority in 2009, unlike 1991–1992, these were temporary transfers (less than one year, and typically for just a few months), and they were approved as "Temporary Changes in Place of Use, Purpose of Use and Points of Diversion." Because of the temporary nature of the change, California Water Code Section 11729 applied, which exempts temporary water transfers from the requirements of California Environmental Quality Act (CEQA). To the extent that, with climate change, water shortages become a frequent occurrence in California, these temporary adaptations may not be a fully adequate solution. Third, the use of pumped groundwater to substitute for surface water transferred to the Water Bank reinforces the tendency to overdraft groundwater that already exists among surface water users in California. The groundwater replacement contracts add to the concern about the lack of an adequate regulatory framework for groundwater use in California. Fourth, legal maneuvers that were required to permit water to be transferred through the drought water banks entailed some significant transaction costs. Reducing transactions costs and facilitating long-run transfers of water on a larger scale through the modification and better enforcement of surface water rights would be beneficial adaptive responses to the prospect of climate change.

Section 4: California Faces Challenges in Overcoming Barriers to Adaptation for the Water Sector

In California, changes to the existing water rights framework are typically highly controversial, thus there is reason to believe potential adaptive measures may face strong political headwinds. Some water users undoubtedly agree with Kevin Kelly, general manager of the Imperial Irrigation District, who recently said, “It’s built into the DNA here that water is a birthright…” (Barringer 2011). An Imperial Valley farmer, who commented on the importance of water to the area, said, “There was nothing here before the water was here. There will be nothing here after it’s gone.” (Barringer 2011). Such sentiments suggest that some adaptive measures may not be politically feasible at this time; however, there have been a number of recent events that suggest some adaptive measures may be feasible, and this is particularly true in the area of measurement of water use. For both groundwater and surface water, having an accurate record of who is diverting water in California, and in what quantity, is the single most important step towards preparing for climate change.

Section 5: Possible Adaptive Measures for Groundwater

Groundwater is an important resource in California and the west. In an average year, groundwater is used for about 30 percent of agricultural and urban water uses (Littleworth and Garner, p. 69).[49] Of the fresh groundwater pumped in California, about 80 percent is used for irrigation, about 12 percent is provided to entities that supply water to the public, and the remainder supplies a number of other users (livestock, industrial, etc.) (Kenny et al. 2009). Despite a water rights system that treats groundwater separately from surface water, there is widespread agreement that groundwater and surface water are physically connected.[50] Groundwater contributes to about two-thirds of water used for agricultural and or domestic uses, some directly and some indirectly (groundwater seeps into streams and becomes surface flow) (Thompson 2011, p. 265–266). (The connection runs both ways—surface waters also feed groundwater). Groundwater will become even more important as climate changes for two reasons: first, under conditions of scarcity, surface water users will likely shift to groundwater, and second, given the temporal and geographical variations in precipitation, underground storage has the potential to play an important role in adaptation.

Despite the potential contribution groundwater could make, there have been few recent changes to the laws and regulations pertaining to the monitoring and management of groundwater. The State Board, despite a number of legal analyses that suggest it has the authority to manage groundwater under existing law, has not yet exercised that authority. By contrast, about two-thirds of the western states have taken steps to integrate groundwater and surface-water rights (Thompson 2011, p. 270).

5.1 Conjunctive Management of Groundwater

One practice widely viewed as a way to help California adapt is "conjunctive use" (also called "conjunctive management"). Conjunctive use is the practice of managing surface and groundwater together in order to maximize the productive and sustainable use of the waters. Under conjunctive management, surface water is used to recharge groundwater in wet years, and stored water is recovered (used) in dry years. This practice would help the state adapt to climate change since resources are stored, managed, and used effectively. The Department of Water Resources estimates that conjunctive management and groundwater storage together have the potential to increase water supply by between 0.5 and 2.0 million acre-feet per year

[49] Littleworth and Garner, p. 69, citing Groundwater Bulletin 118 – Update 2003, p. 115.

[50] Even the ACWA acknowledges this fact. ACWA, "Groundwater Management in California: A Framework," p. 14.

(DWR 2009, Vol. 2, p. 1–10). The current system of water rights, leaving groundwater extraction unmeasured and largely unregulated, is a significant impediment to conjunctive management.[51]

5.2 Recent Developments That Point to Movement in the Area of Groundwater

Despite the State Board's lack of action in the area of groundwater, there are currently a number of signs that point to possibility of movement in the area of groundwater. As described below, there have been recent developments in the areas of legislation, policy analyses, water suppliers, and court actions. Nonetheless, groundwater remains a controversial area, as evidenced by the failure of the 2009 water legislation to include many new requirements in the area of groundwater. Legislation in this area may be difficult in the absence of some type of crisis such as a multi-year drought, or more evidence of extreme overdraft.

Recent Legislative Activity Related to Groundwater

There has been some successful legislative activity in the area of groundwater, suggesting that further action may be possible. The 2009 water legislation that was enacted included some provisions that pertained to groundwater (many of the stronger provisions were stripped from the final version of the legislation, however). In 2011, AB 359 (Huffman) was enacted.[52] AB 359 requires local water agencies to include in groundwater management plans a map that identifies areas that substantially contribute to groundwater recharge. That information is then provided to local planning agencies to help inform land use planning decisions. Agencies that fail to take these steps are ineligible for State funds for certain groundwater projects.[53]

State Entities and Policy Centers Have Turned Their Focus to Groundwater

The importance of groundwater to the state is reflected in the recent proliferation of reports on groundwater management. Several recent reports have suggested reforms. For example, the State Legislative Analyst's Office (LAO) recently issued a report calling for improved management of groundwater resources (LAO 2010), as did a report from the University of California, Lost Angeles's (UCLA's) Emmett Center on Climate Change and the Environment (Enion 2011), a report from Stanford University's Woods Institute for the Environment (Nelson 2011), and a report from the Public Policy Institute of California (Hanak et al. 2011). The LAO's report recommends comprehensive monitoring, increased management of areas with greatest overdraft potential and/or most extensive pollution, the modernization of groundwater law to

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[51] While the injection and extraction of water into the aquifer by the conjunctive use authority is typically monitored, the pumping of groundwater from the aquifer by overlying (agricultural) landowners is typically unmonitored and unregulated. When surface water is injected into an aquifer for conjunctive use storage, this raises the water table and lowers the pumping cost for overlying landowners. When the water is extracted from the aquifer, this lowers the water table and raises the pumping cost for overlying landowners, which has been a source of controversy for them.

[52] AB 359 (Huffman) Chapter572, Statutes of 2011.Accessed 10/25/2011. http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_359&sess=CUR&house=A&search_type=bill_update

[53] Water Code Section 10753.7(a).

reflect physical interconnection of surface water and groundwater, and the consideration of establishing statewide groundwater permitting, while maintaining some local control (LAO 2010, p. 3). The UCLA report calls for comprehensive monitoring of groundwater use, levels, and quality, and for a comprehensive framework for the regulation of groundwater in which local jurisdictions are given clear guidelines and mandatory management goals (Enion 2011, p. 1–2). The Stanford report notes that local groundwater management plans serve as a source of promising and innovative management practices. It also calls for strengthening California's legislation for groundwater management planning so that more stakeholders are involved in water planning, more and a broader range of information is collected (including ecological information), and plans use a "portfolio" approach to management and include demand management (Nelson 2011, p. 33).

The Association of California Water Agencies Has Proposed a New Groundwater Framework

Perhaps anticipating reforms, the Association of California Water Agencies (ACWA) issued a report on groundwater titled *Sustainability from the Ground Up: Groundwater Management in California, A Framework* (ACWA 2011). The report was developed "…to advance sustainable groundwater management as part of the State's overall water management portfolio."(ACWA 2011, p. 3). The report opposes a state-administered water rights system for groundwater, since, "…California has developed and refined an effective system of locally controlled groundwater management over the past century"(ACWA 2011, p. 13) (a statement seemingly contradicted by recent data on the extent of groundwater overdraft). But the report acknowledges that surface water and groundwater are "often interconnected from a hydrologic perspective,"(ACWA 2011, p. 14) and calls for "a continued and intensified commitment to conservation and water use efficiency."(ACWA 2011, p. 25). The report further calls for comprehensive data collection and analysis of groundwater quality and quantities, and proposes that the data be made "transparent and accessible to interested stakeholders…."(ACWA 2011, p. 26, 30). Although eschewing statewide management of groundwater, the report calls for improved management of groundwater on a regional/local level (ACWA 2011, p. 29). This seeming openness to change may be a sign that even interests formerly viewed as unfriendly to changes in groundwater management may be reevaluating their positions.

The Prospect of an Adverse Result from Pending Litigation May Spur Action

The ongoing litigation about application of the public trust doctrine to groundwater may also spur action. The Environmental Law Foundation (ELF), together with the Pacific Coast Federal of Fishermen's Associations and the Institute for Fisheries Resources, filed suit against the State Water Resources Control Board and Siskiyou County over groundwater extractions that they allege are dewatering the Scott River.[54] The plaintiffs claim that by allowing the extractions, the State Board and Siskiyou County have violated the public trust doctrine. While the ultimate

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[54]*Environmental Law Foundation, Pacific Coast Federation of Fishermen's Associations, and Institute for Fisheries Resources vs. State Water Resources Control Board, and County of Siskiyou, Sacramento* Superior Court, Case No. 34-2010-80000583.

result of that litigation is not yet known, the possibility of an adverse judgment may provide an impetus for movement on groundwater monitoring and management.

Groundwater: Prospects for Change

The recent activity in the area of groundwater combined with new data regarding overdraft suggest that some changes to California's current approach to groundwater regulation may be possible. Groundwater is especially important to climate adaptation. Water banking/conjunctive use has significant potential to help with adaption to climate change because it provides a means by which the seasonal and annual variability in precipitation can be addressed. Storing water underground as opposed to above ground has the additional benefit of reducing evaporation, thereby increasing the supply of available water. For these reasons, moving toward a legal framework that would facilitate water banking is essential. There are a number of possible adaptive measures that would aid in the creation and successful operation of water banks.

5.3 Adaptive Measure: Expand Groundwater Reporting Requirements

One possible adaptive measure would be to expand groundwater reporting requirements to mandate monitoring and reporting of (1) basin elevations, and (2) the volume of groundwater extracted.

Current Law

The 2009 water legislation included SBX7-6, which encourages the monitoring and reporting of elevations of groundwater basins and subbasins. Local water agencies are given the power to monitor and report elevations from individual basins, but there is no requirement that they do so, and the penalty for failure to monitor and report is just the potential loss of eligibility for state grants or loans.[55] As the Emmett Center report points out, the voluntary nature of this provision limits the State's ability to assess the condition of its groundwater resources (Enion 2011, pp. 19–20).

If no entity is monitoring groundwater elevations in a basin or subbasin, the Department of Water Resources can perform the monitoring functions. However, that may prove difficult because under the 2009 legislation DWR cannot enter private property without the consent of the property owner, nor can DWR require a property owner to compile or report groundwater-monitoring information. Moreover, a provision that would have allowed the Department of Water Resources to assess fees to pay for the monitoring was stripped out of the bill.

Changes That Would Facilitate Adaptation

In order to adapt to a changing water supply, it is essential to know how much water is currently being extracted, and by whom. Measurement will provide a baseline, and will allow measurement of the pace of change of use in the face of climate change. In addition, in some

[55] Water Code §10933.79(a).

other areas—notably crime control—measurement appears to have helped spur innovation perhaps because what is measured is visible and valued and can be better managed. Another area where measurement has played an important role is education. In that area, measurement focused attention on school performance, but also may have encouraged teachers and administrators to take steps to artificially inflate test scores. This result underscores the need to ensure that any measurement and reporting system is monitored so that the reported results are accurate and complete.

Recently approved reporting requirements have successfully increased knowledge about water use. The 2009 reporting requirements for surface water diverters increased the number of new Statements of Diversion and Use filed with the State Board from 10,000 to 17,000 (Wilson 2011a, p. 6). Although the version of SBX7-6 that was adopted did address groundwater, it did not go far enough in two important aspects. First, the volume of water extracted is not required to be either monitored or reported. Second, reporting and monitoring are essentially voluntary.

Measurement and reporting of both groundwater elevations and volume of groundwater extracted would facilitate groundwater management and marketing.[56] As previously mentioned, more conjunctive use (groundwater banking) would be an attractive alternative to surface reservoirs if groundwater rights were more clearly established. Experience with water banks suggests that successful water banking may require that groundwater extraction be measured and reported. In Kern County, the home of several water banks, a local utility brought suit against water bank operators because the utility believes extractions from the water banks are causing local wells to run dry. If extractions are required to be monitored and reported, it would be easier to determine whether the bank is extracting water it banked or other groundwater, and conversely, whether overlying users are extracting banked water. If these types of claims could be more easily evaluated and assessed, the uncertainty associated with future legal claims would be reduced.

Moreover, if the data collected shows large extractions with minimal economic benefits, it may spur state legislators to take other steps to improve groundwater management, and may provide users with the motivation to bargain. Of course, for data to be useful there must be sufficient funding for data analysis.

Specific Measures That Would Aid in Adaptation

- Local water districts should be required to measure and report to the State Board groundwater basin elevations; such activities should not be voluntary. The measurement and reporting requirements should be uniform across the state. For maximum transparency, the reported information should be readily available to the public, with

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[56] It should be emphasized that measurement of extraction is the key to effective management of groundwater. Measuring the change in the water table is not a substitute for measuring the extraction by individual users. Measuring the change in groundwater basin elevations can show, for example, that an aquifer is being overdrafted, but it does *not* show *who* is doing the overdrafting, and it is that knowledge which is essential to effective management of the overdraft.

appropriate steps taken to ensure privacy. Any entity that fails to measure and report groundwater elevations or reports inaccurate data should be subject to penalties, not just the potential loss of state grants and loans.

- Except for de minimis (minimal) users, all groundwater users should be required to measure and report to the State Board the quantity of groundwater they pump. The measurement and reporting requirements should be uniform across the state. For maximum transparency, the reported information should be readily available to the public, with appropriate steps taken to ensure privacy. Meters should be required to meet performance standards to ensure that the information reported is accurate. Any user that fails to measure and report groundwater user or reports inaccurate data should be subject to penalties, not just the potential loss of state grants and loans.

5.4 Adaptive Measure: Expand Groundwater Management Planning Requirements

Another possible adaptive measure would be to expand groundwater management planning requirements to (1) require local water agencies to prepare groundwater management plans, and (2) require the Department of Water Resources to prepare a "menu" of groundwater management best practices for use by local water agencies.

Current Law

Under AB 3030, local water agencies whose service area includes all or part of a groundwater basin may choose, but are not required, to prepare a groundwater management plan, provided the basin is not otherwise subject to management pursuant to law, court order, judgment, or decree.[57] The voluntary plans must be adopted following certain procedural steps, including public notice and public hearings.[58] If landowners representing more than 50 percent of the assessed value of the land subject to the proposed groundwater management plan file protests against the plan, the local agency may not adopt the plan.[59] Groundwater management plans may include components that relate to the following 12 areas:

1. Control of saline water intrusion.
2. Management of recharge areas.
3. Control of migration of contaminated groundwater.
4. Administration of well abandonment and destruction.
5. Mitigation of conditions of overdraft.
6. Replenishment of groundwater.

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[57] Water Code §10752 et seq.

[58] Water Code§§ 10753 et seq.

[59] Water Code §10753.6

7. Monitoring of groundwater levels and storage.
8. Facilitating conjunctive use.
9. Identification of well construction policies.
10. Construction and operation of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
11. Development of relationships with state and federal regulatory agencies.
12. Review of land use plans to assess which activities create a reasonable risk of groundwater contamination.[60]

Groundwater management plans are expressly prohibited from making determinations pertaining to water rights.[61] The plans are permitted to limit or suspend extractions, but only after determining "through study and investigation" that other sources of water supply are insufficient to reduce the demand for groundwater.[62] Statewide there are about 200 local agencies that have adopted groundwater management plans (DWR 2003, Ch 2., p. 14). Plans are sometimes required for a local agency to be eligible for state funds for the construction of groundwater projects or groundwater quality projects.[63]

Changes That Would Facilitate Adaptation

To adapt to a changing water supply, it is essential to manage groundwater resources using the best possible management practices for a given set of conditions and to expressly consider climate change when making management decisions. Three recent reports, from different sources, have focused on the importance of local action in the area of groundwater management. Noting that "many local districts have developed sophisticated and innovative groundwater management plans," the Emmett Center report called for a template for statewide rules and management goals, with local agencies adopting either the template or their own set of equivalent rules (Enion 2011, p. 22). Similarly, describing some elements of groundwater management planning in local groundwater management plans as "exceptional" and "promising and innovative,"(Nelson 2011, p. 1, 33) the Woods Center report calls for strengthening legislation for groundwater management planning, while "retaining the State's historical focus on local agencies driving local change" (Nelson 2011, p. 33). Last, calling groundwater management plans "among the most effective and widely used management techniques in California," the ACWA report called for most groundwater basins identified in DWR Bulletin 118 to be operated "consistent with a locally developed groundwater management plan that achieves sustainability," and whose development "should be open and

[60] Water Code §10753.7

[61] Water Code §10753.8(b)

[62] Water Code §10753.8(c)

[63] Water Code §10753.7(a)

transparent to allow public engagement in the process and should specifically address all factors related to groundwater management" (ACWA 2011, p. 29).[64] Although there are benefits to a state-wide system of groundwater management, such a system is unlikely to be adopted in the near future. A modified version of the ACWA proposal—one that mandates local planning—may also face opposition, but may prove to be more palatable to groundwater users than a state-wide approach. Voluntary action, the system currently in place, has not been sufficient to prevent large-scale overdraft of groundwater.

Water management would be improved in three important respects by legislation that would make groundwater management plans mandatory for all significant basins and subbasins not adjudicated or otherwise subject to management, that would require consideration of climate change, and that would require the Department of Water Resources to compile and make publically available a list of best management practices obtained from groundwater management plans. First, groundwater management planning would be expanded to include all significant groundwater basins and subbasins and would encompass climate change. Second, the local water agencies undertaking groundwater planning efforts would have access to information about best management practices used across the State. Third, local agencies, which often have better access to information about which practices are most useful and effective in their area, would be able to implement those best practices that would allow them to manage their groundwater resources most effectively.

Specific Measures That Would Aid in Adaptation

- Require local water agencies to develop a groundwater management plan in significant groundwater basins that are not otherwise managed.
- Groundwater management plans currently may include components that relate to 12 areas. One new area should be added; namely, the mitigation of adverse conditions projected to arise as the result of climate change.
- Require the Department of Water Resources to review Groundwater Management Plans and prepare and make readily available a list of best practices.

5.5 Adaptive Measure: If Feasible, Encourage or Empower the State Board to Improve Groundwater Management

Another possible adaptive measure, if feasible, would be to either require the State Board to use its existing authority under the "reasonable and beneficial use" doctrine, or to enact legislation that would empower the Board to improve groundwater management.

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[64] An important issue is how local is "local"? For local management of an aquifer to be meaningful it must embrace all the overlying land users, since they all have the legal right to extract groundwater from it. A local management entity that covered only part of the overlying land would be relatively unproductive.

Current Law

In contrast to appropriative water rights, where there is a statewide permitting system, California's groundwater is largely unregulated at the state level. Instead, in California, to the extent that groundwater is managed, that management occurs on the local level, by local agencies. Overlying landowners can build groundwater pumps and extract groundwater without a permit. As a result, more water is extracted from California's aquifers than is naturally replenished. California and Texas remain the *only* two western states that allow groundwater pumping without a permit (Enion 2011, p. 2).

Although regulation of groundwater has long been controversial, there has recently been increased pressure to move toward a management scheme for groundwater that recognizes the physical connection between surface water and groundwater, and treats the two similarly. Calls to do so were made as long ago as 1912. The physical connection between groundwater and surface water is at the forefront of the ongoing litigation over the Scott River in Siskiyou County, and was addressed in Professor Sax's 2002 report prepared for the State Board. As Sax noted, "[h]ydraulically connected groundwater and surface water ought to be managed in a single integrated system, and that has been the general direction in which many states have moved."(Sax 2002, p. 10).

Other States Compared: Kansas and Nebraska

In the area of groundwater management and regulation, Kansas and Nebraska suggest different models for groundwater management. Originally, Kansas followed the Absolute Ownership Doctrine under which a landowner could pump groundwater subject only to a prohibition on malicious or wasteful uses. In 1945, following New Mexico, Utah, and Nevada, Kansas adopted a prior appropriation doctrine for groundwater. Similar to California surface water, under this system pre-1945 overlying users of groundwater had vested rights and were not required to obtain a permit, while post-1945 users were required to apply to an administrative agency for an appropriative right (Peck 2007, p. 299; Dunbar 1977, pp. 662-680). In response to extensive groundwater mining following the development and rapid adoption of center pivot irrigation supplied based on groundwater, in 1972 the Kansas legislature approved the Groundwater Management District Act (GMDA). Kansas Statutes Annotated 82a-1020–82a 1040. Pursuant to that act, five Groundwater Management Districts (GMDs) collectively covering a portion of the state have been created (Peck 2007, p. 299). Groundwater Management Districts are created only if a majority of eligible voters cast votes in favor of created of a GMD.[65] The GMDs have broad powers, among which are the power to install or require the installation of meters to determine the quantity of water withdrawn, to adopt standard and polices relating to the management of the district, and to levy water user charges. K.S.A. 82a-1028(h), (l), and (n). For example, GMD3, located in the southwest of the state, implemented three restrictions to reduce depletion:

[65]K.S.A 82a-1025(b). Eligible voters are defined to mean, "a natural person 18 years of age or older, or a public or private corporation, municipality or any other legal or commercial entity" that either has any interest in land of 40 or more contiguous acres within the GMD and not within any municipality, or, uses one acre-foot or more of groundwater per year within the boundaries of the district. K.S.A 82a-1021(a)(5).

minimum distances between water wells, depletion criteria to restrict the amount of water allotted to each well, and limits on the amount of water that could be requested for each acre of irrigated land.[66] Those measures failed to prevent over-appropriation of non-domestic water uses, so the District implemented additional measures, including safe yield criteria and the closing of certain townships to further appropriation (Southwest Kansas Groundwater Management District 3 report 2004, p. 10.).

By contrast, Nebraska groundwater law traditionally relied on the "rule of reasonable use," with the doctrine of correlative rights used during times of shortage (Kelly 2010, p. 14). This hybrid approach has been codified in state law, but made subject to the Nebraska Ground Water Management and Protection Act, enacted in 1975, which states:

> "Every landowner shall be entitled to a reasonable and beneficial use of the ground water underlying his or her land subject to… the Nebraska Ground Water Management and Protection Act and the correlative rights of other landowners when the groundwater supply is insufficient to meet the reasonable needs of all users." Nebraska Revised Statutes 46-702.

Nebraska has established 23 Natural Resource Districts (NRDs) based on river basins that cover the entire state (Peck 2007, p. 300). Natural Resource Districts are authorized to establish ground water management areas if needed to protect ground water quality or quantity, or to prevent or resolve conflicts between users of ground water and appropriators of surface waters where the surface and ground water are hydrologically connected. N.R.S. 46-712. Among the steps that an NRD is authorized to take in a ground water management area are the following. It may:

- allocate of the amount of ground water that may be withdrawn by water users,
- adopt well-spacing requirements,
- require installation of well metering devices,
- require reductions in irrigated acres,
- prevent or limit the expansion of irrigated acres, and/or
- require ground water quality monitoring and reporting (N.R.S. 46-739).

In 2004, the Nebraska legislature enacted LB 962, which authorizes the Department of Natural Resources (DNR) to declare a river basin fully or over-appropriated and to work with local NRDs in the affected basins to prepare integrated surface water/ground water management plans. In basins determined by DNR to be fully appropriated, immediate stays or moratoriums on new uses of surface and ground water in the basin are implemented until the management plan is in place.

The management of groundwater by GMDs in Kansas and NRDs in Nebraska differs from that exercised by counties in California in several important ways. First, the GMDs and NRDs are

[66]Southwest Kansas Groundwater Management District 3, "GMD3 Revised Management Program, Draft Version," June 9, 2004, p. 10, http://www.gmd3.org/PDF/040609_GMD3_mngt_pgm_textonly.pdf (accessed February 7, 2012).

established according to hydrologic boundaries, rather than to administrative boundaries. The counties in California that have adopted groundwater ordinances cover only part of the aquifers involved, and therefore do not offer a coherent framework for the management of the aquifer. Second, the GMDs and NRDs exercise stronger authority than that afforded by the county ordinances in California. In particular, GMDs and NRDs (1) meter groundwater extraction, and on occasion, (2) limit groundwater extraction. Neither (1) nor (2) occurs in California outside of adjudicated groundwater basins. Third, in Nebraska, the management of groundwater is integrated with the management of surface water; whereas, as noted earlier, in California the regulation of these two types of water is kept entirely separate.

It is evident that there would be strong opposition in California to the enactment of groundwater legislation similar to that adopted in Kansas and Nebraska. It is important to understand the distinctive factors that led Kansas and Nebraska to adopt their legislation. The concern that triggered the legislation in those states was the interaction between groundwater extraction and stream flow in major rivers. Groundwater extraction was seen as significantly depleting stream flow in several major rivers at the time the legislation was introduced. Moreover, several of these were interstate rivers and the depletion of stream flow had been the subject of litigation among the states which led to the signing of interstate compacts and/or U.S. Supreme Court decrees, including the South Platte River Compact (Nebraska and Colorado), the North Platte River Compact (Wyoming, Colorado, and Nebraska) the Republican River Compact (Colorado, Nebraska, and Kansas), and the Arkansas River Compact (Colorado and Kansas). The interstate conflicts about stream flow provided the crucial incentive for groundwater regulation.

A possible implication is that future meaningful action to control groundwater overdraft in California might become feasible if and when the overdraft is seen to interfere in a significant manner with surface water diversions from some major rivers. Climate change could potentially become a factor in bringing this about by contributing to both increased groundwater pumping and reduced stream flow at key times of the year.

Changes That Would Facilitate Adaptation

The lack of quantified groundwater rights and the failure to treat surface water and groundwater in a single integrated system will impede the State's ability to handle reduced surface flows and increased uncertainty and variability, and will prevent or delay the ability of the public and private sectors to make decisions related to adaptation. Sax's legal analysis found that the State Water Resources Control Board (SWRCB) has jurisdiction over groundwater uses that "…diminish appreciably and directly the flow of a surface stream…" and that the Board should use that jurisdiction and its existing authority to prohibit wasteful and unreasonable uses of groundwater in order "…to protect surface resources from groundwater diversions." (Sax 2002, p. 92). Whether the Board takes such action may depend on the result of the Scott River case, which is currently pending in the courts. If, either on its own initiative or are the result of legislation, the State Board takes action to prevent wasteful and unreasonable uses of groundwater, groundwater management would be improved.

Recently, UCLA's Emmett Center looked at how to best accomplish this goal; that is, how to best integrate groundwater management with surface water management and permitting. The report concluded that the most likely path forward was not the establishment of comprehensive statewide rules for groundwater use. Instead, the report recommended that the state create a template for statewide rules and management goals, and that local or regional agencies be required to either adopt the template or to create an equivalent set of rules (Enion 2011, p. 22). Alternatively, the state could be allowed to step in if local or regional agencies fail to act. This approach would accommodate regional differences, and allow local agencies to take advantage of their existing groundwater management plans. Such an approach would be similar to the "cooperative federalism" of the Clean Air Act, an approach that has been successful (Thompson and Nelson 2010, p. 3). Under the Clean Air Act, the U.S. Environmental Protection Agency establishes national ambient air-quality standards, while the states develop and enforce implementation plans to attain the standards. The Emmett Center report concludes that the following measures are essential elements of groundwater regulation: (1) determine groundwater rights in all basins, not just adjudicated basins; (2) enforce restrictions on groundwater use and prevent unmonitored withdrawals; (3) determine and implement a "sustainable yield" for groundwater withdrawal; (4) remove the legal distinction between percolating groundwater and subterranean streams; and (5) allocate groundwater through shares (the Australian approach), rather than by the entitlement approach currently used for surface waters (Enion 2011, pp. 22-25). At this time, there is not sufficient political consensus for all of these measures, but some subset may be feasible. Improved collection of data about groundwater withdrawals and aquifer status may be helpful in alerting agricultural interests to the threat to their future needs posed by excessive current withdrawals. This might help ease the path toward greater acceptability of regulation.

Specific Measures That Would Aid in Adaptation

- Require the State Board to create a template for statewide rules and management goals for the management of groundwater, and provide the template to local or regional water agencies for their use.
- Require the State Board to use its existing authority under Water Code Section 275 to "prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state," and its existing authority under the Article X, Section 2 of the California Constitution to limit the use of water "to such water as shall be reasonably required for the beneficial use to be served."[67]

[67] Professor Joseph Sax's 2002 report concluded that the State Board had jurisdiction over certain groundwater uses. The State Board chose to take no action in response to that report. This measure would entail legislation to require the State Board to take the actions proposed by Professor Sax.

Section 6: Possible Adaptive Measures for Surface Waters

As is the case with groundwater, there has been much recent activity in the area of surface water. The 2009 water legislation included a number of provisions that were stripped out at the last minute, but that would aid in adaptation to climate change. In addition, the Little Hoover Commission, in 2009 and again in 2010, reported on water rights, and possible improvements to the administration and management of water rights and water supply. The high profile of water, combined with evidence of at least some support from legislators and public advocates for changes, suggest that some additional regulatory and legislative changes may be possible.

6.1 Adaptive Measure: Improve Agricultural Water Use Efficiency

Another possible adaptive measure would be to improve agricultural water use efficiency by either adopting numerical water conservation standards for agricultural users or by requiring the State Board to enforce existing reasonable and beneficial use requirements.

Current Law

The part of the 2009 water legislation that addresses conservation requires urban per capita water use to be reduced by 10 percent in 2015, and by 20 percent in 2020.[68] The efficiency requirements for agricultural water supplies that were ultimately adopted are much weaker and do not contain numerical standards (Frank 2010, p. 24). Agricultural water suppliers (those suppliers that supply water to 25,000 or more irrigated acres, excluding recycled water) are required to measure the volume of water provided to users so that the supplier can to adopt a pricing structure based "at least in part" on the quantity of water delivered. Such water suppliers shall also implement "additional efficient management practices" provided those practices are "locally cost effective and technically feasible."[69] Agricultural water suppliers are also required to submit agricultural water management plans that report which efficient management practices have been or are planned to be implemented.[70] By contrast, earlier iterations of the legislation applied to much smaller agricultural water suppliers—those that supply water to more than 2,000 irrigated acres, or supplying more than 2,000 acre-feet of agricultural water (excluding recycled).[71] Earlier iterations also mandated some of the "efficient management practices that in the adopted legislation are only required if "locally cost effective

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[68] Water Code Section 10608.16(a), (b).

[69] Water Code Section 10608.48.

[70] Water Code Section 10608.48(d).

[71] AB49 (Feuer and Huffman), amended April 13, 2009, S§10608.12(a) http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_0001-0050/ab_49_bill_20090413_amended_asm_v98.html (accessed October 27, 2011).

and technically feasible."[72] Failure to comply with these provisions renders water suppliers ineligible for certain state water grants and loans. The Department of Water Resources is currently in the process of developing and adopting regulations to implement this statute, but final regulations have not yet been issued. The latest draft of proposed regulations allows suppliers to measure deliveries upstream of the farm-gate if either (1) the supplier lacks legal access to the farm-gate, or (2) conditions are such that the measurement device is not comparable in cost to other measurement devices "commonly in use" (DWR 2011).

Perhaps because the legislation that was enacted lacked numerical standards for agricultural water users, the Delta Watermaster, Craig Wilson, recently issued a report that called for the State Board to use its existing authority under "reasonable and beneficial use" doctrine to encourage efficient water use in the agricultural sector (Wilson 2011b). In the report, which elicited negative reactions (Boxall 2011),Wilson proposed that the State Board conduct one or more hearings "… regarding the best ways to use the Reasonable Use Doctrine to promote more efficient use of water in the agricultural sector," looking both at delivery improvements and at on-farm improvements. Wilson suggested that the hearings focus on a number of specific recommendations. Those included the following measures:

1. Create a Reasonable Water Use Unit within the State Board, using funds previously allocated, and with a mission "to enforce the prohibition against the waste or unreasonable use of water…in a wide variety of settings."[73]

2. Streamline procedures for enforcement action pertaining to waste and unreasonable use. The current process consists of nine steps, including an investigation, three hearings of the State Board, and issuance of three orders by the State Board. Wilson's proposal would reduce that number to five.

3. Conduct adjudicatory proceedings in situations where agricultural water use is thought to be inefficient, which might ultimately result in legal proceedings that would test the legal theory underlying Wilson proposal.

4. Use the Reasonable Use Doctrine as a means to increase the efficiency of agricultural water use in two areas: water delivery system / irrigation scheduling improvements, and agricultural conservation measures.

   (a) In the area of water delivery, require operators of irrigation water delivery systems to provide famers with irrigation water "on-demand." At present, that requirement applies only to large irrigation systems. Water Code sec. 10608.48, subdivisions (c)(5).

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[72] The criterion of "locally cost-effective" is quite limiting because it generates a test that ignores the opportunity cost of water and also, in many cases, the capital cost of a replacement supply.

[73] A template for such a unit could be the regional network of water rights offices established in Wyoming in 1886 to monitor local diversions and enforce seniority.

(b) In the area of agricultural conservation measures, require those agricultural users who file with the State Board Statements of Diversion and Use (Water Code Sections 5100 and following), to submit information about the practices they employ to use water efficiently.

5. Study water transfers "to determine how much water is conserved and to develop a streamlined method for calculating such savings."
6. Include provisions that require the efficient use of water in relevant statewide plans (e.g., the Bay Delta Conservation Plan).
7. Last, use bond funds and other funds to "...promote agricultural efficient projects."

While some of these proposals may not politically feasible at the present time, it may be possible for others to be adopted.

Changes That Would Facilitate Adaptation

Agriculture is very important to the State's economy. In 2009, California's 81,500 farms led the nation in cash receipts, which totaled $34.8 billion, or 12.3 percent of the U.S. total (CDFA 2010, p. 17). The sheer size of the agricultural sector in California suggests that efficiency improvements could result in reductions in water demand. Whether achieved by legislation or changes in State Board practices, improved agricultural water use efficiency would facilitate adaptation by reducing demand. Currently, urban users use about 20 percent of California's developed water supply, while agricultural users use about 80 percent. The Department of Water Resources estimates that agricultural water use efficiency has the potential to reduce water demand by as much as 1.0 million acre-feet per year (the high estimate), with a low estimate of 0.1 million acre-feet per year (DWR 2009, Vol. 2, p.1–10). Increased agricultural water use efficiency has the additional benefit of being among the least costly means for managing California's water. The DWR estimated the cost of agricultural water use efficiency to range from $85 to $675 per acre-foot of water. By contrast, the cost of urban water use efficiency is estimated to range from $223 to $522 per acre-foot of water. This suggests that there may be some relatively inexpensive measures that could be taken by agricultural users to reduce water demand (DWR 2009, Vol. 2, p 1–12). It is worth noting that no other resource management strategy has a low estimate below $100 per acre-foot, while one measure, ocean desalination, has a low estimate of $1,000 per acre-foot (DWR 2009, Vol. 2, p. 1–12).

We recognize that there is a debate over whether increased efficiency in agricultural water use would provide more water to the system. Researchers at the Pacific Institute concluded that water savings from more efficient agricultural water use range from 0.6 to 3.4 million acre-feet per year (Cooley et al. 2008, p.6). Researchers at The Center for Irrigation Technology, California State University, Fresno, concluded that the water savings would be much less, just 330,000 acre-feet per year (Canessa 2011, p. i). The discrepancy appears to focus on what happens to water used inefficiently—in what quantities the excess water is returned to the water systems through field runoff and percolation into groundwater (Canessa 2011, p. 5). Even if all the excess water returns to the ground or surface water bodies, there are two reasons for concern. First, the return flows can be contaminated to some degree with salts naturally occurring in the soil and/or with chemicals applied by during cultivation farmers (e.g., pesticides). Second, the location of water matters for the management of water resources: diverting an excessive quantity of water and then generating a large return flow to a different location in the stream, or in an aquifer, and at a different point of time, makes a difference if one is trying to manage stream flow to permit, say, the emigration of juvenile anadromous fish to the ocean or the return of anadromous fish from the ocean to their inland spawning grounds. It is not harmless. Third, a persistent syndrome of over-diversion, over-irrigation, and excessive generation of return flows subverts the sound administration of water rights. The return flow is ultimately transferred to other users of surface or ground water who did not have a right to that water and obtained it only because the user who did have a valid right abused the right by over-diverting and over-irrigating.

Specific Measures That Would Aid in Adaptation

- Require the State Board to create management goals for water suppliers in the agricultural sector, and to prepare a portfolio of efficient management practices to help agricultural water suppliers attain those goals. There is no mandate to reach the goals, but one could be included in the future.
- Require the State Board to identify agricultural practices that involve the waste or unreasonable use of water in a wide variety of settings in order to educate agricultural users. This is not calling for enforcement of those practices, but enforcement could occur in the future.
- Streamline State Board procedures for enforcement actions pertaining to the waste and unreasonable use of water.
- Define "agricultural water supplier" to include suppliers smaller than those included in the adopted legislation, which defined the term to include only those suppliers providing water to 10,000 or more irrigated acres, excluding recycled water.

6.2 Adaptive Measure: Increase Enforcement of and Penalties for Failure to Comply with Surface Water Reporting Requirements

Another possible adaptive measure would be to increase the enforcement of and penalties for failure to report diversions, and for illegal diversions.

Current Law

Although certain diverters of water have been required since 1966 to file a Statement of Water Diversion and Use,[74] until recently there were no penalties for failing to file the required Statement. The 2009 water legislation expanded reporting requirements and for the first time imposed fines for failing to file a statement.[75] The fine is $1,000, plus additional fines of $500 per day for each day that the violation continues after the diverter was notified by the State Board of the reporting requirements.[76] The 2009 legislation also increased the fine for the illegal

[74] Water Code Section 5101.

[75] Water Code Section 5107(b).

[76] Water Code Section 5107(c)(1).

diversion of water from $250 per day to $500 per day. Earlier versions of the water legislation, which were not adopted, were much stronger. They proposed that the penalty for illegal diversion be the greater of the following: $1,000 per day ($5,000 per day for repeat violators) or the highest market value of the water.[77] The 2009 legislation did require delta diverters, who were previously exempt from reporting requirements, to report their diversions. As mentioned previously, these requirements resulted in significant increases in reporting; further strengthening the requirements and penalties may result in additional reports being filed (Wilson 2011a, p.6).

Changes That Would Facilitate Adaptation

Understanding the quantities and timing of existing uses is key to adaptation. Such information would provide a baseline that could be used to evaluate the pace of change in supply and demand over time, and would also better enable California to manage changes in stream flow. Moreover, in the near-term, an awareness of the quantities used may spur conservation measures. Also, expanding enforcement and increasing penalties would further spur diverters to comply with expanded reporting requirements, and would allow regulators to determine whether the volume of water being diverted falls within the permitted amount. Together, these steps would help position California to adapt to climate change, and may encourage diverters to begin to bargain so that the water is used in the most economically efficient manner. As discussed in Section 2, a permanent funding source for the administration, analysis, and enforcement of the Statements program would allow the State Board to effectively implement the program. At this time, it may not be politically feasible to impose a fee on diverters to fund this program, and there is legal uncertainty about the precise parameters of such a fee (see the discussion of Proposition 26, below). Increased penalties, however, could be used for such a purpose.

Specific Measures That Would Aid in Adaptation

- Increase the penalty for failing to file a Statement of Water Diversion and Use, or for making a material misstatement in connection with such a filing, with repeat violations subject to higher penalties.
- Set the penalty for illegal diversion to the level originally proposed, that is, the greater of the following: $1,000 per day ($5,000 per day for repeat violators) or the highest market value of the water.[78]

[77] SBX7 5 Water Code Section 1052(c).

[78] As discussed in Section 2, the Delta Vision Task Force called for legislation that would give the State Board the authority to issue interim orders to prevent irreparable harm. Earlier versions of the 2009 water legislation also included provisions that would give the State Board the authority to take interim action. Such legislation may be desirable, but may not at this point be politically feasible.

6.3 Adaptive Measure: Increase Funding for Water Rights by Imposing a Regulatory Fee on Users Who Benefit from Water Rights Administration

Another possible adaptive measure would be to expand the water rights holders subject to a regulatory fee to include riparian, pueblo, and pre-1914 appropriative rights holders to fund the enforcement, monitoring, and administration of the water rights system.

Current Law

In 2003, the Legislature adopted Water Code §1525 in order to fund the operations of the Water Rights Division of the State Board. Prior to that time, funding came from the general fund. Of the state water used pursuant to a claim of water rights, 40 percent are rights regulated by the State Board pursuant to a permit or license, 22 percent are rights held by the federal government, and 38 percent are riparian, pueblo, and pre-1914 appropriative rights (these users do not need a permit or license from the State Board). The 2003 legislation required those holding a permit or license (including federal rights holders) to pay a regulatory fee to the State Board to fund the Division of Water Rights. If the holder of the right declined to pay on the grounds of sovereign immunity, the legislation allowed the State Board to allocate the fee to entities with contracts for the delivery of water from the sovereign. No fees were imposed on riparian, pueblo, or pre-1914 water rights holders. In *California Farm Bureau Federation v. State Water Resources Control Board,* (2011) 51 Cal. 4th 421, the California Supreme Court held that the fee was a constitutional regulatory fee requiring approval by a majority of the legislature, not a tax requiring approval by two-thirds of the legislature (California Constitution, article XIII A, section 3).

Changes That Would Facilitate Adaptation

A regulatory fee imposed on all users of water who benefit from California's water rights administration, particularly one based in part on volume of water used, would facilitate adaptation in two ways. First, it would be a means to ensure that water rights enforcement, monitoring, and permitting were adequately funded so that water users were able to obtain the water to which they held a right to use. Second, a charge based on volume may encourage users to become aware of the volume of water they use, and the cost of making sure that water is available to them and not taken by someone without a right to do so. This effect, however, would likely be small given the modest rates currently in place. An additional benefit of this measure is that it might help to clarify those who hold water rights pursuant to riparian, pueblo, and pre-1914 rights not subject to State Board permitting requirements. Although this adaptive measure is likely to be controversial, it may be feasible since it is similar to the 2003 legislation, which was successfully adopted in the face of opposition.

Unlike the 2003 legislation that predated Proposition 26, a regulatory fee imposed today must comply with Proposition 26. That proposition added to the state constitution a provision that requires a supermajority vote (two-thirds of all members of each of the two houses of the

Legislature) for all new taxes.[79] "Tax" is broadly defined to mean "… any levy, charge, or exaction of any kind imposed by the State…."There are exemptions for charges imposed for "a specific benefit conferred or privilege granted" or for "a specific government service or product provided," or "the reasonable regulatory costs to the State incident to issuing licenses and permits. "However, even in those instances the charge cannot "exceed the reasonable costs to the State" of that activity.[80] It may require years of litigation to determine the legal interpretation of Proposition 26. In this context, some of the issues might include whether access to public water resources is a "privilege granted" by the state or a "government service or product;" under what circumstances a government program regulating and enforcing a system of water rights is a "government service" to water users who are not subject to the post-1914 permitting requirements (for instance, by preventing the illegal diversion of water by others); how closely benefits must be matched to each individual entity assessed the fee; and how "reasonable costs" are to be determined.

Specific Measures That Would Aid in Adaptation

Given the legal uncertainties posed by Proposition 26, it may be advisable to authorize state agencies to impose fees for specific actions (such as protecting pre-1914 water rights) on those water rights holders, with some administrative process to determine the beneficiaries and the reasonable costs. We recognize that this may be difficult to do given that such water rights holders are not required to obtain a permit, but they still benefit from the water rights system even though they themselves are not required to obtain a permit.

6.4 Adaptive Measure: Require Water Users to Claim Their Rights, or Forfeit Said Rights

Climate change will alter historic patterns of runoff and streamflow that serve as the basis for existing water rights, changing the timing of runoff and reducing the volume of streamflow that occurs during what is currently the irrigation season. One adaptation to climate change will be shifting the irrigation season to begin earlier in the year. Since appropriative water rights are defined with respect to a specific set of dates, changes in the irrigation season will likely require the issuance of new water rights for the early part of the years. And reductions in streamflow during the main part of the summer will create new shortages with respect to existing water rights for diversions at that time. As climate change progresses, these hydrological changes will place increasing stress on the administration of water rights in California. Many other western states have by now adjudicated all the major sources of surface water diversion. California has not. Many water users, especially the smaller ones, have preferred to shield their water use within the obscurity of the existing system. However, the existing imprecision and incompleteness of many existing water rights in California will make it harder—if not impossible—to resolve the water conflicts that will arise in the face of unprecedented changes in hydrology. To reduce the stress and facilitate adaptation, it would be greatly beneficial to clarify

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[79] California Constitution, Article 13A, Section 3(a).

[80] California Constitution, Article 13A, Section 3(b).

and firm up existing water rights in California ahead of time. Under existing procedures, that could be done by a general stream adjudication. This type of adjudication has been eschewed in California because it is likely to be massively time consuming and expensive for participants. A desirable adaptive measure would be to find some alternative approach to systematically quantifying the existing water rights to divert surface water before the main brunt of climate change is upon us. There is some precedent in the area of mining claims for an approach that would require water users to prove their water rights within some reasonable period of time.

Current Law

Under current law, existing water diverters are not required to prove they have a right to divert water unless a stream or groundwater basin is in the process of being adjudicated. It would be very costly and time consuming to require all diverters to "prove" their rights, but it will be very difficult to manage climate-related changes in streams and groundwater basins without knowing who actually has a right, and to what quantity of water. Moreover, the lack of clarity and precision in water rights impedes the development of a more functional water market. Water rights cannot be sold or transferred if they are not defined. A more functional market would also help water users by giving them an additional tool to hedge their risks, and would likely reduce the cost of water. The 2009 Water Legislation included a provision that required all diverters of water from surface streams or underground streams to file a Statement of Diversion and Use with the State Water Resources Control Board. That legislation applies broadly, and includes those who divert water pursuant to a riparian right and those who divert water pursuant to a pre-1914 right.

Changes That Would Facilitate Adaptation

Requiring water users to prove their water rights would likely face opposition at this time, unless it can be done with lower transaction costs that presently exist. This is particularly true of the pre-1914 rights, which were established before the State Board took charge of administering appropriative water rights. Those rights, of course, will be the most difficult to determine because the evidence about the initial diversions is now almost a century old or even older. That said, once significant climate changes are evident, there may be a willingness to address this issue. Many people now recognize that some sort of general adjudication is required, but are concerned about the cost in time and money of conventional stream adjudication. One possible first step would be to require water users to *go on record* regarding what they think are their water rights.[81] Proving the asserted right comes after that.

Such a requirement would be similar to legislation adopted for mining claims on public lands. Prior to 1976, there was no federal recording system for such claims, and no way to determine

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[81] As discussed in Section 2, the Delta Vision Strategic Plan called for legislation that would give the State Board the authority of initiate stream adjudications and collect adjudication costs from the parties diverting water. Earlier versions of the 2009 water legislation included provisions that would have given the State Board such authority. At this time such legislation likely lacks the political support to be enacted, but it, too, would help clarify water rights.

whether the claims were valid, or even which public lands were subject to mining.[82] To remedy that situation, Congress enacted the Federal Land Policy and Management Act of 1976 (FLPMA).[83] The FLPMA included "…a recording system designed both to rid federal lands of stale mining claims and to provide federal land managers with up-to-date information that allows them to make informed land management decisions."[84] Specifically, mining claims were required to be registered with the Bureau of Land Management (BLM) within three years of adoption of the FLPMA, and every year thereafter claimants were required to file with state officials and BLM a notice of intention to hold the claim.[85] Failure to file the annual report in a timely manner resulted in automatic forfeiture of a claim, a result that was upheld by the U.S. Supreme Court in *U.S. v. Locke* (1985), 471 U.S. 84. Something similar could be done in the area of water rights. The reporting requirements in place since 2009 could be supplemented by a requirement that diverters state what they believe their water rights to be. At some point in the future it may be feasible to add a provision that failure to file results in forfeiture of a claim to water. Given the lack of clarity in water rights and the considerable uncertainty in times of drought, people may be willing to make concessions in return for having their rights clarified.

[82]*U.S. v. Locke* (1985), 471 U.S. 84, 87 (holding that holders of unpatented mining claims who fail to comply with the annual filing requirement of the Federal Land Policy and Management Act shall forfeit their claims).

[83] 43 U.S.C. §1701 *et seq*.

[84]*U.S. v. Locke,* at 87.

[85]*U.S. v. Locke,* at 88-89.

Section 7: Moving Beyond What May Be Currently Feasible

There are a number of measures that will aid in adaptation and that may be feasible in the current political climate, including many of those discussed above, such as increased reporting and monitoring, increased enforcement, increased conservation, improved water markets, and others. Shoring up California existing water rights systems will put California in a better position to adapt to climate change, by at least creating a baseline of use and supply, and by providing information about the pace of change in the water sector.

There are other measures that are not currently feasible. If the projections for sharp reductions in streamflows, increases in variability, and increased demand come to pass, however, the current system of prior appropriation with seniority based on a historical hydrology that is increasingly irrelevant may face growing political opposition. Then, there may be the political will to switch (with a grace period and perhaps some compensation) to a new framework for water rights.

This occurred in Australia, which responded to a prolonged drought with a switch from a water rights scheme based on the right to extract an absolute amount of streamflow to a right to a proportional share of inflow (Australia's experience was that water markets alone did not adequately respond to extreme water scarcity). The current appropriative system in California places the risk of drought on junior users, while more senior users are protected from risk. That is, during times of drought senior users receive their entire allocation while junior users receive no water at all. (At least this is true in theory, but given the lack of clarity about appropriative rights, the senior user may actually own only the right to a lawsuit against allegedly junior users.) Under the Australian system, risk is shared—each party receives some water, but less than their full amount. This approach, which is similar to the idea of correlative rights that currently applies to riparian users and users of percolating groundwater, would allow for more flexibility in use. Rather than leaving some agricultural fields fallow and others growing thirsty crops, the Australian model encourages all users to take steps to conserve water. Any such changes in California would be more difficult than in Australia, however, and would require extensive consideration and investigation.

As with surface water, some adaptive measures pertaining to groundwater are not currently feasible, for example, the regulation of groundwater extraction. In the face of drought and overdraft, however, there may be the political will to make changes to the current system of groundwater rights. In the meantime, obtaining information about the quantity of groundwater extracted, and about groundwater basin elevation levels, will provide stakeholders with the information they will need to determine the impact of climate change on groundwater use and resources. That information will also be useful in helping select adaptive measures.

In conclusion, climate change (coupled with future population increases) will exacerbate the current conflict over California water because it will result in increased demand and decreased supply. Adaptation will be needed to address the projected changes to the available supply of water and to the demand for water. For successful adaptation to occur, there are a number of prerequisites, almost none of which are currently in place. The adaptive measures identified in this paper consist largely of feasible changes to the existing legal and institutional framework associated with California's water rights allocation system that would help put those prerequisites in place. Other, more far-reaching changes may be possible in the future.

Glossary

AB	Assembly Bill
ACWA	Association of California Water Agencies
BLM	Bureau of Land Management
Cal/EPA	California Environmental Protection Agency
CDFA	California Department of Food and Agriculture
CEQA	California Environmental Quality Act
CVP	Central Valley Project
DNR	Department of Natural Resources
DWR	Department of Water Resources
ELF	Environmental Law Foundation
FLPMA	Federal Land Policy and Management Act of 1976
GMDA	Groundwater Management District Act
GMDs	Groundwater Management Districts
LAO	State Legislative Analyst's Office
NASA	National Aeronautic and Space Administration
NRDs	Natural Resource Districts
PIER	Public Interest Energy Research
RD&D	Research, Development, and Demonstration
SWP	State Water Project
SWRCB	State Water Resources Control Board
UCLA	the University of California, Lost Angeles

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