California Water Adequacy Laws: What Potential for Climate Change Adaptation?

by

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"Scarcity precipitates conflict"

Judge J. Raye

Planning and Conservation League v. Department of Water Resources

Executive Summary

This paper assesses the potential effectiveness of California's water adequacy laws, specifically Senate Bill 610 and Senate Bill 221, as climate change adaptation tools. To undertake the analysis, I reviewed legislation, case law, and a selected municipal plan. This provided an analytical understanding of the law's functioning. The definition of adaptation and the five evaluation factors of 1) anticipatory vs. reactive adaptation, 2) appropriateness of time horizon, 3) data gathering and use, 4) scope of application and 5) support of flexibility were identified through a review of climate change adaptation literature. I applied the factors in an assessment of California's Water Adequacy Laws and discuss the findings.

I discovered through my assessment that I could make no supportable conclusion regarding the effectiveness of California's water adequacy legislation due to a lack of information. However I did draw several conclusions about the laws potential as climate change adaptation tools. The legislation was introduced in a timely manner to help the state adapt to climate change impacts on its water supply. The twenty year time period for water adequacy, acts as an appropriate minimum when combined with freedom for local governments to enact more stringent regulations. While the legislation does not explicitly require information gathering, it does demand decisions based on high quality data. It addresses an appropriate spatial area and types of development but its threshold for triggering the state regulation is too high. The laws also support flexible responses to changing conditions due to their five year review requirement. While these laws may not be rigorous enough for California's precarious climate situation, I support the translation of this tool to other jurisdictions with improvements such as increasing penalties for non-compliance.

Project Purpose and Research Objectives

The overall purpose of this project is to explore the strengths and weaknesses of California's water adequacy laws as climate change adaptation tools. I describe the characteristics of an effective climate change tool to judge the ability of these laws to function as such. For this review, I identify five evaluation qualities from the general climate change adaptation literature.

1. Determine if the adaptation tool was introduced reactively, concurrently or anticipatorily; anticipatory is preferred?[1]
2. Does the tool have an appropriate time horizon (e.g. a tool which deals with public infrastructure investments should consider more than the next ten years?)
3. Does the instrument require the collection and utilization of data which will support future adaptive actions?
4. Does the instrument consider three factors appropriate for the problem? The factors are: the spatial scope to which the legislation applies; the type of developments targeted; and the size of the developments which trigger a review of water adequacy.
5. What is the legislation's ability to allow or support flexibility in the face of new information or situations?

Using these evaluative qualities, I develop and describe the legislation's strengths and weaknesses and make recommendations for its future use.

Problem Statement

Climate Change Impacts on Water Supply

The primary components of the hydrologic cycle are condensation, precipitation, evaporation and transpiration.[2] Condensation is when water moves from a gas state to a liquid or solid state. Precipitation is when water particles fall from the atmosphere to earth. Evaporation is when water moves from a liquid or solid state to a gas. Transpiration is when water stored in plant material is released as water vapour to the atmosphere.[3] Climatic conditions fluctuate naturally in cycles that range from years to centuries and longer. Climate scientists predict that these fluctuations will soon exceed the historical norms. All four components of the hydrologic cycle will be affected by these projected changes[4].

[1] Smit et al., "An Anatomy of Adaptation to Climate Change and Variability," 224.
[2] National Oceanic and Atmospheric Administration, "Description of Hydrologic Cycle"; Stzepak et al., "Chapter 6: Water Resources," 6-2.
[3] National Oceanic and Atmospheric Administration, "Description of Hydrologic Cycle."
[4] Smit et al., "An Anatomy of Adaptation to Climate Change and Variability," 226.

Climate change will cause more frequent and intense droughts which will affect water availability both during single-years as well as over more extended time periods.[5] These impacts will affect surface water supplies due to reduced flows, greater flow variability and increasing rates of evaporation. Groundwater will be impacted though reduced recharge.[6] Since 1976, California has recorded droughts ranging from two to six years in duration and regular flooding has occurred during strong storm events.[7] Engineers and geographers studying the impacts of climate change on hydrologic cycles predict that these events will intensify, greatly impacting water supplies across the midlatitudes of the United States.[8]

A significant part of California's water supply comes from its Colorado River allocation. This allocation was negotiated in 1922 by the states of California, Colorado, Wyoming, New Mexico, Arizona, Nevada, and Utah.[9] The allocation was based on an intensely wet period of time. We now understand that the total water supply estimated to be available annually from the Colorado River for the 1922 negotiations, did not represent the typical Colorado River flow rates. Therefore, normal or dry years create situations where the river is over-allocated, meaning there is less water available than states hold the right to use. Several other major southwestern river basin allocations were negotiated during the same high-precipitation time period and face similar problems. Arizona State University researcher Jim Holway predicts that the effects of climate change on precipitation and evaporation will exacerbate the problem.[10]

Water Supply and Development

Population, natural resources, consumption traits, technology, governance and adaptation determine the sustainability of a water supply.[11] The California Department of Finance predicts that California will have a population of almost fifty million people by 2030.[12] This is an increase of almost sixteen million

[5] Cooley, Christian-Smith, and Gleick, *Sustaining California Agriculture in an Uncertain Future*, 9.
[6] Stzepak et al., "Chapter 6: Water Resources," 6-3.
[7] *State of California General Plan Guidelines*, 129.
[8] Loaiciga et al., "Global warming and the hydrologic cycle," 83.
[9] "The Colorado Compact."
[10] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 237-238.
[11] Ibid., 235.
[12] Department of Finance, *Population Projections for California and its Counties 2000-2050, by Age, Gender and Race/Ethnicity*.

people from the most recent U.S. Census data from 2000 which was 34 million.[13] This population growth will put stress on already scarce water resources. Moreover, water supply is extremely weather-sensitive. Extreme weather events will be one of the first climate change impacts.[14] As freshwater sources become harder to access due to expense, location and climate variability, development will increasingly be limited by water supply. The impasse between development demanding more water than is available hydrologically, will be decided by legislative authorities at all levels of government.

In the Southwest United States, agriculture uses the most water, with industrial and municipal water uses accounting for only 14 to 27% of demand. As illustrated in Table 1, only 18% of California's water demand is from municipal and industrial users. Approximately 50% of municipal water use is used for residences, with half of that used for landscape irrigation. In the past, water scarcity stimulated construction of large and expensive infrastructure projects designed to move water long distances using cheap energy.[15] This practice is no longer viable due to rising economic and environmental costs. Developers can no longer always assume that water supplies will be made available because many states have passed legislation which requires developers to prove the existence of an adequate water supply prior to construction.[16] This requirement has increased the rate of water-rights transfers from the agricultural to residential sector. Researcher Jim Holway from Arizona State University points out that irrigation for landscaping is displacing irrigation for agriculture.[17]

Table 1 – Statewide consumptive water use by sector (percent of total demand) (Reproduced from: Holway, Adaptive Water Quantity Management)

Sector	Arizona	California	Colorado	Nevada
Agriculture	74	82	86	73
Municipal	20	17	7	23
Industrial	6	1	2	4
Other			5	
	100	100	100	100

Note: Figures are based on most recent statewide data available. 2006 for Arizona and Colorado and 2000 for California and Nevada. All data from state agency websites

[13] Department of Finance, *Census 2000: Summary File 1 California Profile.*
[14] Fankhauser, Smith, and Tol, "Weathering climate change," 68, 71.
[15] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 238-240.
[16] Hanak and Browne, "Linking Housing Growth to Water Supply," 154.
[17] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 238-239.

Local governments must think creatively to address the problem of water scarcity. Communities across the American West are beginning to establish a link between the development they allow within their jurisdictions and the adequacy of water supplies to support it. This comes as communities begin to recognize the negative externalities that are being created through unregulated growth.[18] The impacts of climate change and growth leaves states and communities with the responsibility of allocating their water supplies in more strategic and sustainable ways while planning for the long term.

The California Situation

One solution used by California was water adequacy laws that demand developments of a certain size to undertake a process to determine if an adequate, reliable water supply is available for the next twenty years. If not, the development cannot proceed.[19] This process involves both public and private entities but the final decision is made by local governments.[20] In the Southwestern United States, overdrafting of groundwater is common because water supplies are almost entirely allocated.[21] Senate Bill 610 describes the declining reliability of water delivery systems over the last twenty years in California. This is due to practices such as the overdrafting of groundwater and failing to link water demand by development to the existence of an adequate water supply.[22] California's water adequacy laws link development allowances to water supply to reverse this downward trend in reliability. I evaluate how these laws have functioned in California and their ability to address the challenges caused by climate change to determine if they are a tool that should be used by other governments facing similar challenges.

Methods

A literature review helped me to develop an understanding of what climate change adaptation is and how it manifests. I gathered commonly accepted adaptation criteria and concepts for evaluating water supply legislation, choosing the five most applicable. I chose these criteria because there is no existing

[18] Hanak and Chen, "Wet Growth," 85-86.
[19] Hanak and Browne, "Linking Housing Growth to Water Supply," 156; Hanak and Chen, "Wet Growth," 85.
[20] Senator Kuehl, *Land Use: water supplies*; Senator Costa, *Water Supply Planning*.
[21] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 248.
[22] Senator Costa, *Water Supply Planning*.

framework for evaluating the efficacy of water supply legislation as a climate change adaptation tool. Next I examine the use of water adequacy legislation in nearby states before delving into how such legislation functions in California. I discuss how the laws have been integrated into government policy by focusing on water planning documents in a selected California community and general state trends. Ancillary state legislation which relates to water adequacy is also reviewed. I examine legal cases to understand the court challenges to this type of legislation and its predecessors. Finally, I use this background knowledge and qualities to evaluate California's water adequacy laws.

Literature Review

What is Climate Change Adaptation?

Mitigation, vulnerability and adaptation are used to discuss climate change. I predominately address adaptation in this paper. Mitigation means to "abate, moderate or alleviate" [23] the cause of anticipated impacts. An example of a mitigation action is reducing GHG emissions to reduce the severity of climate change.

Vulnerability is:

> *the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.*[24]

Using this definition, I identified California as a place with high water supply vulnerability because of 1) nearly fully allocated water supply,[25] 2) the unreliability of the Colorado River allocation,[26] and 3) high population growth predictions.[27] The combination of a virtually fully allocated water supply combined with high population growth makes California increasingly susceptible to the effects of climate change impacts on the Colorado River flows and other major water sources.

Adaptation to climate change is defined in a variety of ways.

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[23] Smit et al., "An Anatomy of Adaptation to Climate Change and Variability," 224.
[24] Intergovernmental Panel on Climate Change, "Climate change 2007," 20.
[25] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 248.
[26] Ibid., 238.
[27] Department of Finance, *Census 2000: Summary File 1 California Profile.*

It means…*adjustments in ecological-social-economic systems in response to actual or expected climactic stimuli, their effects or impacts.*[28]

Adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer term climate change.[29]

The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change.[30]

Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions.[31]

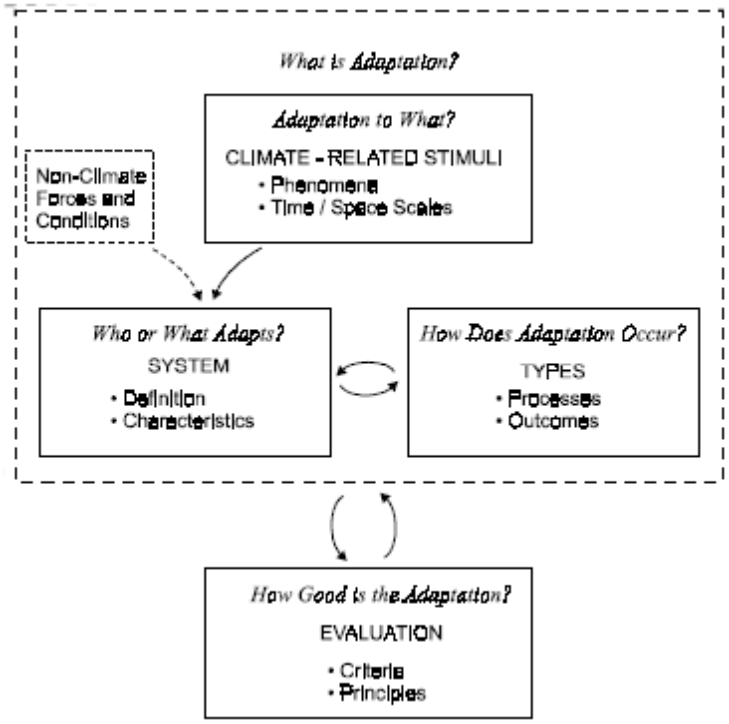
These definitions provide insight into how researchers think about climate change adaptation. I assume these perspectives influence the spread and popularity of adaptation tools. I include their definitions to determine if the water adequacy legislation is an adaptive measure.

[28] Smit et al., "An Anatomy of Adaptation to Climate Change and Variability," 225.
[29] *Adaptation to Climactic Variability and Change*.
[30] Stakhiv, *Evaluation of IPCC Adaptation Strategies*.
[31] Watson et al., *Climate change 1995*.

Adaptation Actors and Actions

Figure1 illustrates the general outline of information regarding adaptation and orients the reader to the relationships between sections of the paper. The box called, "Adaptation to What?" cites "climate-related stimuli" such as the flooding and storm events in California discussed in the introduction of this paper. California's socio-economic system corresponds with the box labeled "Who or What Adapts?" and adapts to the climate-related stimuli, constrained by the "non-climate forces and conditions" such as political feasibility. The adaption referred to in the box called "How Does Adaptation Occur?" acts through the legislative regulations required by Senate Bill 221 and 610. Finally my evaluation qualities determine the water adequacy law's potential success as a climate change adaptation tool.

Figure 1 - Gross anatomy of adaptation to climate change and variability (Reproduced from Smit et al., An Anatomy of Adaptation to Climate Change and Variability)



Evaluation Criteria for Climate Change Adaptation Literature

Successful adaptation requires three main elements: "timely recognition of the need to adapt, an incentive to adapt, and the ability to adapt."[32] Recognizing a need for adaptation does not mean the same thing as having an incentive. A person may recognize the need to reduce their water demand but may wait until they have the incentive of a high water bill to begin changing their habits. All evaluative criteria were chosen considering this framework.

[32] (Fankhauser, Smith and Tol 1999, 68-69)

Autonomous or Planned Adaptation

Autonomous, (spontaneous) adaptation and planned adaptation represent the two processes for entities to choose and implement adaptive actions. In the findings section, I discuss which process was responsible for SB 221 and 610 and discuss the opinions over the efficiency of each type. A good climate adaptation tool is an efficient tool.

Autonomous vs. planned adaptation decisions are differentiated by the lens through which they are viewed. For example, the State of California decides to adapt to climate change by reducing demand for water. The state legislature passes a law which requires plastics manufacturers to reduce their water use by ten percent. Any action taken by the manufacturers to comply with this legislation would be a planned adaptation from the state government lens. If the same manufacturer reduced their water use by 10% without the state law then the state would consider it an autonomous adaptation. This distinction is important to the arguments over the efficiency of each type of adaptation.

Environmental economist, Robert Mendelsohn, supports autonomous adaptation as the more efficient method and describes what he calls "joint-adaptation" as the most efficient. Joint adaptations are private adaptations that have multiple beneficiaries and are supported by government action. However, he predicts that joint-adaptations are unlikely to occur due to political pressure pushing governments to undertake inefficient adaptations. He concludes that any governmental involvement in adaptation is likely to be inefficient.[33]

Fankhauser, Smith and Tol suggest that for successful autonomous adaptation to occur, individuals must have "the right incentives, resources, knowledge and skills to adapt efficiently." They identify a role for government in ensuring that individuals have these (e.g. laws which make externalities part of the decision-making for individuals).[34] Holway suggests that state-level governments can have a similar role in relation to local government decision-making. He states that the best adaptation results can be achieved by the implementation of a strong state-level regulation which can act as a stop-gap measure to prevent municipalities from completely ignoring concerns over development approvals and water supply while still allowing municipalities to use their discretion to determine if stronger regulation is

[33] Mendelsohn, "Efficient adaptation to climate change," 585.
[34] Fankhauser, Smith, and Tol, "Weathering climate change," 74.

required.[35] This idea is discussed in relation to SB 221 and 610 in the Time Horizon section of the findings.

Resources for Adaption

The ability of an entity to adapt depends on available resources and the recognition that there is a need for adaptation. Wealthier nations have more resources than poor countries.[36] An example of wealth supporting an adaptation project is the Thames Barrier in the United Kingdom. The Thames Barrier comprises giant flood gates which can be opened and closed to protect London from storm surges. The United Kingdom recognized that London is at risk for higher and more frequent storm surges due to climate change and invested resources in adaptation. The total cost for the project was £1.3 billion pounds in current money.[37] There are many delta cities which have the same vulnerability as London who cannot afford to take such steps even when they recognize the need for it. While California is currently a rich state in a rich country, its situation may change drastically in the future due to climate change impacts on important state industries such as agriculture.

Criteria for Assessing Climate Change Adaptation Tools

While there are many important characteristics for climate change adaptation tools, there are no assessments of tools for water supply legislation. Because there is no previously developed standard for evaluation, I have used my own judgement in choosing important tools from general climate change adaptation literature. Below are the evaluation qualities.

1. Were SB 221 and 610 introduced Reactively, Concurrently or Anticipatorily?
2. Do the water supply adequacy planning requirements in SB 221 and 610 span an appropriate amount of time?
3. Is climatological Data Gathering and Integration supported by the requirements of SB 221 and 610?

[35] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244.
[36] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-10.
[37] Wallace, "The Thames Barrier - A Systems Study."

4. Do SB 221 and 610 address an appropriate spatial area, type of development and size of development?
5. Is flexible planning supported by the legislative requirements of SB 221 and 610?

Quality 1- Reactive, Concurrent, or Anticipatory Adaptation

Different kinds of adaptation occur at different times in relation to climate change events. Adaptations can be reactive (in response to stimuli), concurrent (during) or anticipatory (responding to predicted impacts).[38] Laws can address all three of these. An example of a reactive law is prohibiting new construction on hill sides greater than forty-five degrees after intense rainfall caused the failure of many such homes. An example of a concurrent law is Frederick, Maryland enacting a moratorium on new construction during a drought in 2002.[39] An anticipatory law would be a law banning new development below twenty feet above sea level in response to predictions of sea level rise.

Quality 2 - Time Horizons

Some of the greatest impacts of climate change will be temporal and spatial changes to precipitation and temperature trends. Changes in weather extremes will be noticed in advance of mean climate norms. Weather-sensitive infrastructure represents a large proportion of water supply investments. Because of the impacts of climate change, the efficacy of current water infrastructure will be greatly tested.[40] Weather-sensitive infrastructure must be a priority area for climate change adaptation. Effective legislation will support a time horizon which encompasses predicted impact of climate change over the lifespan of the project. [41]

Adaptation is easier to implement in shorter socio-economic cycles. It is easier for a farmer to adapt to a change in precipitation in the short term, by planting a more drought or water tolerant annual crop but more difficult for a vineyard because their cycle of cultivation and harvesting requires a longer time span. Adaptation measures must therefore be calibrated to reflect the length of the life-cycle

[38] Smit et al., "An Anatomy of Adaptation to Climate Change and Variability," 240; Fankhauser, Smith, and Tol, "Weathering climate change," 68-70.
[39] McKinney, "Linking Growth and Land Use to Water Supply."
[40] Stzepak et al., "Chapter 6: Water Resources," 6-28.
[41] Fankhauser, Smith, and Tol, "Weathering climate change," 68, 71.

affected.[42] A major water supply infrastructure project like a reservoir and water delivery pipelines can take fifty years to move from design to completion.[43] This type of infrastructure is extremely expensive to retrofit to respond to changing climactic conditions such as heavier rainfall. The expense of changing the design or structure at a later date means that adaptive decisions need to be included as soon as impacts are predicted.[44] Because of the long life of large-scale and high-cost water infrastructure investments, adaptation policy measures must be undertaken at a much earlier date than those addressing a shorter socio-economic cycle.

Three economists writing about climate change adaptation support a "cost-benefit analysis" guided decision which delays investment in adaptation as long as the cost of investment is higher than the projected damages from the event(s). This is problematic for weather-sensitive infrastructure due to the unpredictability of extreme weather events and the fundamental problem of identifying benefits and costs.[45] It is also questionable due to the practice of discounting. Discounting is the practice of using a "discount rate" in a financial analysis to compare some value in today's dollars to the value of those dollars in the future. Discounting reduces future value relative to the present.[46] Because of this practice, high initial costs for infrastructure such as installing grey water systems in new development, are weighted much higher than the long term benefits which are accrued from lower water bills for the lifespan of the house and the reduced need for water treatment and provision. Grey water is water which has not been treated to be suitable for drinking but can still be used for uses such as flushing toilets and irrigating landscaping.

Effective adaptations are sensitive to the complexity of the system they target. If an adaptation measure targets an entire socio-economic or ecological system, the difficulty of adaptation will increase with the scale of system complexity.[47] An adaptation meant to reduce the vulnerability of homes along the coast of California would impact tax revenue, housing prices, building codes, coastal erosion and insurance rates systems to name a few. An adaptation measure which called for reforesting logged areas to protect the snowpack from melting earlier due to higher mean temperatures would affect

[42] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-7.
[43] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 253.
[44] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-7.
[45] Fankhauser, Smith, and Tol, "Weathering climate change," 70-71.
[46] "Restoration Economics: Discounting and Time Preference."
[47] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-7, 5-8.

many more systems. Because of this, adaptation actions must be as sensitive to the complexity of the systems they target as they are to the system's lifespan.

Quality 3 - Data Gathering and Integration

One of the fundamentals for managing a system is good data on past and current conditions.[48] Comprehensive adaptation actions require reliable and detailed inputs (e.g. impact assessment or climate data.)[49] Decision-makers must understand what the baseline conditions are and were for both temperature and precipitation. Strzepek, a professor of engineering at the University of Colorado, states that information must be collected on a monthly or more frequent basis for statistical validity. Monthly is not defined by the author. To adequately address such long term phenomenon as climate change, the data must be available for decades or longer.[50] The more complex the system modeled, the higher quality the data must be.[51] Decision-makers are limited by the availability of inputs and should include data gathering as a goal of adaptive action.

Many data collection agencies such as the U.S.'s National Oceanic and Atmospheric Administration (NOAA) and Weather Service are publicly funded in their collection of climatological data. However, comprehensive data collection has been hampered by shifting priorities within governments and agencies as well as a lack of interest from the private sector. While the market for reliable data will grow and encourage the private sector to begin more intense participation, the private sector will still have to rely on agencies like NOAA for comprehensive historical data.[52] Decision-makers such as state legislators must write legislation to efficiently contribute to that comprehensive historical data library. The private sector supplying climate change data might also be of debatable worth, in contrast to the current publicly-funded, publicly-owned model. Private ownership of climate change data could cause poorer countries to be denied access when their vulnerability is among the highest.

[48] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 252.
[49] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-12.
[50] Stzepak et al., "Chapter 6: Water Resources," 6-23.
[51] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 252.
[52] Fankhauser, Smith, and Tol, "Weathering climate change," 75.

Quality 4 - Factors addressed by adaptation tools

There are many beneficial uses of water. Examples of market uses are agriculture (which often pays a discounted rate), energy production (e.g. hydroelectric or thermoelectric), and domestic water use. Non-market uses of water are tourism, recreation, aesthetics and aquatic ecosystem integrity[53]. It is harder to place a monetary value on non-market uses of water. The two factors identified below are important traits for a climate change adaptation tools that address this diversity of uses and beneficiaries.

One factor is the spatial area impacted by the adaptation tool. Water management covers both groundwater and surface water. These are often managed separately at a sub-basin scale. However, at any larger scale they must be managed together to achieve a coherent and effective adaptation plan.[54] I conclude that water supply legislation which addresses both surface and groundwater should impact the minimum spatial scale of a river basin.

A second factor is determining if the appropriate level of government implemented the adaptation (e.g. county or city councils or the California State Legislature). Adaptation tools that contain a strong regulatory component are able to resist public opinion more easily if introduced at a state or federal level. For example, it would be more politically feasible for the California state government to require the installation of grey water systems in all new construction in California than for individual counties or cities. This separates the local governments whose immediate incentives are to keep housing prices down and encourage construction, from the public pressure to approve developments which would contribute to rising demand for water. Hanak refutes this, instead suggesting that adaptation decisions are best made at a local government scale which can take local circumstances into account.[55] She states that because the decisions which affect water demand are within the jurisdiction of local governments they should be the primary decision makers.[56] Holway suggests that the best result would be from a state-level program that encourages local governments to take the lead in regulation but has a regulatory policy which can act as a failsafe if the local system is unable to make the adaptation changes necessary.[57] I support Holway's position that a good adaptation tool involves a strong regulatory

[53] Stzepak et al., "Chapter 6: Water Resources," 6-3.
[54] Ibid.
[55] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244; Hanak, "Finding Water for Growth," 1032.
[56] Hanak, "Finding Water for Growth," 1032.
[57] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244.

minimum standard set by the state government while allowing intensification of the regulation by local governments. If local governments were able to make these changes on their own then SB 221 and 610 would not be necessary.

Quality 5 - Flexibility

Resources (e.g. time, money and data) are an integral part of operationalizing flexible adaptations.[58] Decision-makers must develop a variety of adaptation actions to respond to the complex impacts of climate change. A large part of that adaptive response for water supplies will be in the planning and construction of expensive infrastructure. In the past, large capital infrastructure projects have been based on historical hydrological conditions. In the future, climate change will be difficult to predict on a small scale and so infrastructure decisions will have to reflect a range of possible outcomes. If a spillway were under-designed and extreme precipitation occurs, the facility could be heavily damaged. While if a facility is over-built, millions of dollars will have been spent needlessly.[59] Clearly the choice of "over-building" will be a project specific decision contingent on its vulnerability. Adaptation tools must provide and promote flexibility in infrastructure design and planning which can respond to changing conditions.

There are two approaches to infrastructure design and construction that increase adaptability. The first is decreasing the planned lifespan of the infrastructure to allow redesign to occur more often. The second is that infrastructure design can be engineered to increase the range of climatic conditions under which it can perform; however as tolerance increases, performance often diminishes. This is highly dependent on structure type. For long-lived investments such as dams and sanitation systems, retrofitting or scraping the systems can carry an even higher cost than increasing the design's tolerance to extreme weather events.[60] This indicates that adaptive design and construction for expensive infrastructure should be dependent on individual project characteristics and regular reassessment of the climate impacts for which it is being designed.

Adaptation requires changes from the "business-as-usual" mindset so it is important to have a flexible and informed public that is willing to support both those who propose the adaptations and the

[58] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-12.
[59] Stzepak et al., "Chapter 6: Water Resources," 6-21; Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-7.
[60] Fankhauser, Smith, and Tol, "Weathering climate change," 73.

adaptations themselves.[61] An inflexible political climate would prevent pre-emptive adaptive measures; instead they can only be introduced concurrently or in reaction to an event. Often the public must experience disaster before they accept lifestyle-impacting adaptations. Of course once programs are established, stakeholders often become vested in preserving the benefits they accrue through that program.[62] A flexible public attitude is also important to support regular reassessments of water supply planning so changing circumstances can be addressed. Maintaining a flexible public attitude can therefore be as important as having one that accepts the initial adaptation.

Arizona, Colorado, Nevada and New Mexico Water Adequacy Legislation

Legislation is not developed in a vacuum. All southwestern states experience similar water supply pressures and have developed their own legislative tools to address it. This is a review of the four states closest to California and their water adequacy legislation. I gathered this information to demonstrate the alternate approaches that California's neighbours took to similar water supply problems. This will inform my understanding of what legislative actions are possible for California. California's actions are detailed in the following section.

Arizona

The state of Arizona employs water adequacy laws as part of its Groundwater Management Act (GMA), passed in 1980. The water adequacy act was passed in reaction to the extraction of water from aquifers at a rate significantly higher than the recharge rate[63]. The recharge rate of an aquifer is the amount of time it takes a set amount of water to move from the surface into the aquifer. Recharge rates can vary from a year to millions of year depending on the type of aquifer.

Arizona's laws establish Active Management Areas (AMAs) in the most populated areas of the state. The boundaries of the AMAs are delineated by groundwater basins and sub-basins. The AMAs are designed to achieve safe yield from the groundwater resources in these areas. Safe yield is the balance between the amount of water withdrawn from an aquifer and the amount of water which recharges it on a yearly

[61] Burton, Smith, and Lenhart, "Chapter 5: Adaptation to Climate Change: Theory and Assessment," 5-10.
[62] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 251.
[63] McKinney, "Linking Growth and Land Use to Water Supply."

basis. However, the GMA allows impacts on springs and surface flows (e.g. springs can go dry) from groundwater withdrawal in AMAs, so safe yield is not a "sustainable" yield.[64] Because both groundwater and surface water are used to meet water supply needs in many states including California, this kind of adaptive measure could damage the predictability of surface water supplies.

The state-legislated AMAs require that all new subdivisions demonstrate a secure, 100-year supply of water; otherwise the local government must refuse to approve the subdivision.[65] Water sources considered "renewable" (e.g. Colorado River water or recycled effluent) must constitute a primary portion of that supply.[66] The state legislature acted very strongly to regulate groundwater withdrawals in 1980. However they retained all decision-making power at the state level. It was only in 2007, that the state government passed that legislation which gave local government's limited rights to regulate water adequacy requirements both inside and outside the AMAs. [67] This legislation allows local governments to choose to impose even more stringent regulations inside or outside of AMAs, as well as regulate groundwater withdrawals outside of the AMAs. This action brought Arizona closer to the partnership approach espoused by Holway.[68]

Colorado

In Colorado, local government control of water regulation is much stronger than in Arizona. State legislation requires that groundwater be managed so that it will be available for a period of 100 years.[69] State law is silent on the length of time "water adequacy" is required for new development unless groundwater is a part of the supply. In 2008, additional legislation was passed requiring local governments to demand proof of an adequate water supply before approving subdivisions of over fifty

[64] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 243-244.
[65] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244-245; McKinney, "Linking Growth and Land Use to Water Supply."
[66] McKinney, "Linking Growth and Land Use to Water Supply."
[67] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244-245.
[68] Ibid., 244.
[69] Hanak and Browne, "Linking Housing Growth to Water Supply," 156.

units while still remaining silent on the length of time that was. It also granted local governments the right to include smaller developments in this requirement.[70]

Counties must establish and enforce water adequacy standards for new development in unincorporated areas but cities can choose whether or not to establish their own standards, subject to the state fifty-unit development requirement. Because there is no state standard, municipal standards vary from twenty to 300 years. El Paso County, Colorado made headlines by introducing a 300-year supply rule in 1986.[71] Another standard used by a Colorado county was to quantify the reliability of the groundwater supply.[72] This lack of a state standard increases the difficulty of planning for water infrastructure and supply on a regional scale.

Nevada

In Nevada, responsibility lies with the State Engineer to approve subdivisions and guarantee their water supply. Utilities serving developments are required to acquire permanent water rights to supply that development. All power rests with the state government or in the case of Las Vegas, the Southern Nevada Water Authority.[73] Like Arizona, Nevada hoards decision-making power at the state level which reduces the collaborative involvement of local governments.

New Mexico

In New Mexico, similar to Colorado, there is also no state standard for water adequacy but most counties require a proven supply of between twenty and 100 years.[74] Groundwater is regulated as a "non-renewable" resource by the state government due to the very low aquifer recharge rates in such an arid climate. Groundwater can be depleted in 40 years according to state law but some municipalities have increased that time period to as long as 100 years.[75] Cities and local governments are also free to establish their own procedures and requirements for determining water adequacy for

[70] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 245.
[71] Ibid.
[72] Hanak and Chen, "Wet Growth," 88.
[73] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 245.
[74] Hanak and Browne, "Linking Housing Growth to Water Supply," 156.
[75] Hanak and Chen, "Wet Growth," 88.

new developments.[76] The City of Santa Fe, New Mexico requires that developers prove that water will be available for their developments for the next 100 years.[77] Proof of water is given by the purchase of water rights or a contract with a water utility. The lack of a state-wide standard causes similar problems to Colorado's for region-wide water resources planning.

The Functioning of Water Adequacy Laws in California

Two major types of water law are used in the United States. These are the riparian doctrine and the prior appropriation doctrine; in California both are used. California also uses a lesser known kind of right called pueblo rights which were established when California was ruled by the Spanish. Riparian doctrine gives access to water by virtue of owning property which borders or includes the water source. Prior appropriation doctrine is recognized when water has been diverted and put to beneficial use. Beneficial use has a broad meaning including irrigation, domestic or industrial use.[78] State legislation identifies domestic use as the "most beneficial" followed by irrigation.[79] All water is owned by the state and water use rights are granted to public and private entities.[80] These underlying doctrines influence how all state court cases and legislation are decided.

The state of California has been dealing with water supply issues for decades and their laws and requirements have developed along with the pressures of development and water scarcity. The state legislature implemented a variety of requirements to adapt to the state's situation. California's water supply legislation requires one or more of the following 1) General Plans, 2) Urban Water Management Plans, 3) water supply assessments and 4) California Environmental Quality Assessments (CEQA). CEQAs, introduce in 1970, was the first state- legislation to address development and water scarcity in California.

In the 1990s the legislature made attempts to force developers to prove that an adequate water supply was available prior to development approval.[81] These were not successful in achieving the legislature's goals. SB 221 and SB 610 are designed to correct the problems with the previous legislation. The following literature review covers legal challenges to environmental impact reviews (EIRs,) conducted as

[76] Hanak and Browne, "Linking Housing Growth to Water Supply," 156.
[77] Odland, Belin, and Atencio, "Jemez y Sangre Water Plan Alternatives Assessment," 3.
[78] Bureau of Land Management, "Western States Water Laws - California."
[79] *California Water Act*.
[80] Bureau of Land Management, "Western States Water Laws - California."
[81] Kibel and Epstein, "Sprawl and" Paper Water"," 24.

part of the California Environmental Quality Act (CEQA) and challenges to water adequacy legislation introduced in 2001 and previously. These pieces of legislation illustrate California's attempts to manage its water in a responsible way to allow for growth without negatively impacting existing residents. The court decisions further clarify the purposes and scope of the previous and current legislation.

Californian Water Supply Legislation

In California, water utilities are responsible for providing water but land use decisions are made by local governments. This disconnection between the actors affecting water supply and demand has been the impetus for legislation which links the two officially to improve coordination and long-term planning. A good example was a development of 11,000 units in Contra Costa County, California in 1992 which was approved by local planners assuming it would be serviced by the East Bay Municipal Utility District (EBMUD) ignoring the district's objections. The EBMUD took the municipal government to court charging that they could not meet current obligations if they were forced to take on this new development. The courts ruled in favour of the EBMUD, invalidating the Environmental Impact Review (EIR) which had accompanied Contra Costa County's approval of the development. This freed EBMUD from being required to service the development unless a valid EIR was approved.[82] The requirements for a valid EIR are discussed further in the California Environmental Quality Act legislation below.

This type of case hastened the introduction of the Costa and Kuehl legislation in 2001 because it drew state-wide attention to the convoluted process of supplying water for development.[83] According to a 2004 survey of municipal and county planners in California, fifty-five percent of municipalities and eighty percent of California's counties required that new housing developments be accompanied by a water supply assessment.[84] These local requirements are equal to and in some cases more stringent than state legislation demands.

[82] Waterman, "Addressing California's Uncertain Water Future by Coordinating Long-Term Land Use and Water Planning," 126-127.
[83] Hanak, *Water for growth*, 51-52; Waterman, "Addressing California's Uncertain Water Future by Coordinating Long-Term Land Use and Water Planning," 126-127; *Urban Water Management Plans: General Provisions*, 10621.
[84] Hanak and Simeti, "Water Supply and Growth in California," 1, 21.

General Plans

All counties and cities in the state of California are required to prepare General Plans. Water is not one of the seven mandated elements for a general policy plan but it is listed among the official "optional elements." The State of California's Guide to General Plans suggests that water supply be addressed in the chapters Land Use, Housing, Conservation, Open Space and Safety.[85] The General Plan from San Luis Obispo will be used as an example, of how proactive a municipality can be with the legislative tools provided by the State of California.

California Urban Water Management Planning Act

This legislation was passed in 1983 and requires water providers to prepare a long-range urban water management plan (UWMP) which are updated every five years.[86] Water providers are defined as those that provide water directly or indirectly for 3,000 customers or over 3,000 acre feet of water annually.[87] Unfortunately this legislation is not adequately enforced and in 2000, only 84% of municipalities required to submit a UWMP had done so. However, this was an improvement of 75% from 1995.[88] Many of the submitted UWMPs are unreliable because of their reliance on "paper water." Paper water is water which is expected to become available in the future as planned new sources of water become available.[89] However, this water does not currently exist and may never exist. Its legal standing will be further described in the legal case Planning and Conservation League v. Department of Water Resources.

There are two consequences for water suppliers who fail to complete a UWMP. First, private citizens may bring suit against the supplier if a period of 18 months passes after the deadline for plan submission. Second, water suppliers are subject to funding restrictions from certain state programs if they fail to submit a plan. Water suppliers are permitted to recoup the costs of the plan preparation through their water rates.[90]

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[85] *State of California General Plan Guidelines*, 49.
[86] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 245.
[87] *Urban Water Management Planning: Definitions*, sec. 10617.
[88] Hanak, "Finding Water for Growth," 1033.
[89] Hanak, *Water for growth*, 42-43, 49.
[90] *Urban Water Management Act*, sec. 10650-10656.

California Environmental Quality Act Legislation

The California Environmental Quality Act (CEQA) legislation introduced in 1970, allowed the alteration or refusal of a development that threatened to cause environmental harm.[91] The legislation directs governmental agencies to balance, qualitative and economic factors as well as short and long-term costs and benefits to determine whether projects are acceptable. If the project is deemed unacceptable, it may be denied completely or ordered altered to mitigate the negative effects. These factors must be evaluated for proposed projects side-by-side with project alternatives which could mitigate environmental impacts.[92] In 1995, a requirement for water supply assessments was integrated into the state's existing environmental quality act reviews.[93]

Kuehl Legislation - SB 221

SB 221 amends the California State Subdivision Map Act to require verification of an adequate water supply for residential housing developments of a certain size. Current urbanized areas and low-income housing are exempt from this legislation.[94] Final approval is given to the development proposal by the local government subject to constraints listed in this legislation. This occurs before construction begins, at the final mapping stage of the development approval process.[95]

Under the California State Subdivision Map Act, local governments must deny approval of subdivision tentative maps or parcel maps that do not meet certain conditions. Subdivisions are defined as, "a proposed residential development of more than 500 units, except that for a public water system that has fewer than 5,000 service connections, "subdivision" means any proposed residential development that would account for an increase of 10 percent or more in the number of the public water system's existing service connections." When a subdivision is filed with the Department of Real Estate, the applicant is required to include several true statements of provision. One of those true statements must be satisfied with a copy of the written verification of an adequate water supply from the applicable water supplier. [96]

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[91] Hanak, *Water for growth*, 51.
[92] *Environmental Quality: Policy*.
[93] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 245.
[94] Senator Kuehl, *Land Use: water supplies*; Kibel and Epstein, "Sprawl and" Paper Water"," 26.
[95] Hanak, *Water for growth*, 141.
[96] Senator Kuehl, *Land Use: water supplies*.

The water supplier's letter specifies that a sufficient water supply will be available to meet the development's needs. A sufficient water supply is defined as, "the total water supplies available during normal, single-dry, and multiple-dry years within a twenty-year projection that will meet the projected demand associated with the proposed subdivision." [97] It must consider a variety of factors including:

1. the historical record of water supplies for a minimum of twenty years;
2. an urban water shortage contingency analysis as defined by Section 10632 of the Water Code;
3. any projected reduction in water sources for a water use sector due to court settlements;
4. and the amount of water the supplier reasonably expects to receive from supply projects, (e.g. reclaimed water or water conservation projects).[98]

The public water system may consider a variety of information sources when making its finding regarding a "sufficient water supply," but the sources must constitute "substantial evidence." Suggested sources in the legislation are:

1. the urban water management plan;
2. a water supply assessment completed pursuant to Part 2.10 of the Water Code;
3. and any other information sources which are similar to the assessment described in Section 10635 in the Water Code.

If water supplies which do not currently exist are incorporated, their future existence must be verified by written contracts, capital outlay programs, permits and any necessary regulatory approvals to support the finding of "sufficient water supply."[99]

The written verification addresses the impacts of supplying water to this new development. The law requires a reasonable description of the foreseeable impacts on agricultural and industrial uses within the public water system's service area. These impacts are considered only in relation to uses which are not receiving water from the public water system but are using water from the same sources.[100] This means that an agricultural operation drawing water from an aquifer which was being used to supply a new development would need to consider the impact of that new development on the shared aquifer.

[97] Ibid.
[98] Ibid.
[99] Ibid.
[100] Ibid.

The legislation grants local governments the right to overrule a finding from a local water system of "insufficient water supply." However, if the local government overrules the finding, they must demonstrate that there are additional water supplies which the local water system did not consider. These supplies must be sufficient for the development and available before its completion. If a local water system fails to respond to a request for verification, the local government can seek a writ which compels the public water system to comply with the request. If there is still no response, the local government is permitted to determine if an adequate water supply for the development exists. Local governments also make the determination if there is no responsible public water system for the development's location. Local governments are not permitted to seek reimbursement from the state government for costs associated with this legislation.[101] Citizens are granted the right to bring suit against any entity (e.g. local government, local water system) which does not fulfill its obligations under this legislation.[102]

Costa Legislation - SB 610

Senate Bill (SB) 610 was introduced by Senator Costa in February of 2001 and enacted in October of the same year. The legislation describes the reasons for its enactment. SB 610 states that "the length and severity of droughts in California cannot be predicted with any accuracy." This increases the difficulty for local governments and water systems to provide reliable adequate water supplies. SB 610 states that the reliability of the water supply in the face of potential multi-year droughts is integral to the economic viability of California businesses and the health of "agricultural industry, environment, rural communities and residents." To improve reliability, the state government directs local water agencies to carefully assess their water supply and delivery systems. The legislation also suggests that reliability can be improved by developing new water sources (e.g. water reclamation, water transfers, and seawater desalinization). Because previous legislation failed to establish the strong link between water supply and land use these new requirements were put forth to improve long-term reliability.[103]

Local governments and water systems are not permitted to seek reimbursement from the state government for the cost of complying with the SB 610. These entities are instead permitted to recoup their costs through levying fees for compliance. The timeframe used for this legislation is five year

[101] Ibid.
[102] Hanak, "Finding Water for Growth," 1033.
[103] Senator Costa, *Water Supply Planning*.

increments adding up to twenty years total. According to the legislation a water supply assessment must be prepared by either the public water system or local government for all developments of a certain size. This assessment is designed to work with the Urban Water Management Plan submitted to the California Department of Water Resources and which is already required of water suppliers. If a UWMP has not been prepared by the water supplier, then the assessment must include all of the same information as a UWMP, only limited to information specific to the development. The requirements for the UWMP or the water supply assessment are listed below.

1. description of the supplier's service areas (e.g. current and project population and climate);
2. detailed information supporting the identity and quantity of the water available for supply with special provisions applying if groundwater is a part of the projected supply;
3. description of the reliability of the water sources and their vulnerability to "seasonal or climactic" shortage, addressing both single and multiple dry years;
4. opportunities for short or long-term exchanges or transfers of water;
5. historical water use by sector in five-year increments;
6. description of the water demand management initiatives that are used by the supplier (e.g. plumbing retrofits, metering, public information campaigns);
7. criteria for evaluating the costs and benefits of implementing demand management initiatives in (6) which have not yet been implemented or are not scheduled to be implemented;
8. and a description of all water supply projects and programs which contribute to the total projected water supply.[104]

Penalties for water suppliers who fail to meet the standards set forth in this legislation are almost identical to the penalties assigned under the Urban Water Management Plan (UWMP) legislation discussed previously. The legislation requires that State of California drought assistance be withheld from any water supplier who has not completed their UWMP plan. In addition, the Department of Water Resources must consider a water supplier's compliance with this legislation and the UWMP legislation when reviewing their candidacy for any funds or program administered by the department.[105]

These requirements apply to a wider range of development projects then those identified by SB 221. This legislation applies to any development which triggers an environmental impact review (EIR) as required by the California Environmental Quality Act. Local governments must identify the water

[104] Ibid.
[105] Ibid.

system providers who are responsible for servicing the new development or, if there is none, the local government must undertake the assessment. Conducting the assessment does not mean that they would be the water provider.

If the water system provider incorporated the proposed development in its most recent Urban Water Management Plan, that plan is used to support a finding of an adequate supply of water. If there is no Urban Water Management Plan or the development was not included, then the service provider must undertake a study to determine if the new development may be serviced while still providing service to the provider's existing customers. The study must consider "normal, single-dry, and multiple-dry water years during a twenty-year projection." Any local government undertaking its own assessment must consider the same factors. The assessment must include:

1. identification of all relevant water supply sources for the project and the amount of water expected to be received from each;
2. proofs such as written contracts, copies of capital outlay programs or permits or regulatory approvals which support the public water services access to the water sourced identified in (1);
3. identification of other water service systems or providers that have access to the same water which has been identified for the project;
4. and if groundwater is identified as a source for the project then strict requirements are laid out.[106]

The assessment must be submitted to the local government responsible for approving the project within 90 days with one extension of 30 days permitted. If an assessment was completed for a large project, subsequent small portions of that project do not require individual assessments unless the project parameters have changed to create significant new demand, the circumstances of the public water system have changed substantially or there is new significant information available.

If this assessment concludes that the public water system is not capable of providing the necessary water supply the water supplier must undertake several steps. The public water system must submit a detailed plan describing their efforts to acquire additional water supplies. This plan includes information

[106] Ibid.

related to total costs for new water supplies, regulatory permits or approvals, and estimated timeframes.[107]

The definitions used in SB 610 are addressed in Section 6. A "project" includes any of the following:

1. residential development of more than 500 units;
2. shopping centres or business establishments which have more than 500,000 square feet of floor space or 1,000 people employed;
3. commercial office buildings with more than 1,000 employees or more than 250,000 square feet of floor space;
4. a hotel, motel or both which have more than 500 rooms;
5. industrial, manufacturing or processing plant or industrial park which projects to have more than 1,000 persons employed or occupies more than 40 acres of land or 650,000 sq feet of floor area;
6. any mixed use project of which any part is described above;
7. and any project which would require water equal to or exceeding the amount of water required by a project with 500 dwelling units.[108]

A "public water system" is described as a system with more than 3,000 service connections. Facilities with the following characteristics are included within this system definition:

1. any treatment, storage or distribution facility which is used primarily by a system and is under its control;
2. any treatment, storage or distribution facility which is used primarily by a system but is not under its control
3. and any third party who treats water on behalf of a public water system.[109]

Legal Challenges and Rulings

When legislative changes to the status quo occur, there will likely be legal challenges. These cases were selected from a legal article written by Kibel and Epstein, two lawyers specializing in Californian water law. The California Environmental Quality Act legislation requires environmental impact reviews for

[107] Ibid.
[108] Ibid.
[109] Ibid.

projects that impact the surrounding environment through their construction; leading to a collection of important legal decisions in the 90s and early 2000s. These cases take place before and after the 2001 legislation. I discuss some of the important cases below. They describe the shape of California's legal use of the Environmental Impact Report requirement and the impact of the 2001 Costa and Kuehl legislation.

Stanislaus Natural Heritage Project v. County of Stanislaus (1996)

This case addressed a 5,000 unit subdivision, scheduled to be built over a twenty five year period. The EIR for this project discussed only the details of the effects associated with the first construction and occupation stage of the project. The county's argument was that the effects of the subsequent construction and occupation stages of the project would be addressed closer to their implementation.[110] When that decision was challenged in court by the Stanislaus Natural Heritage Project, the opinion of the judge was that, "To defer any analysis whatsoever of the impacts of supplying water to this project until after adoption of the specific plan calling for the project to be built would appear to be putting the cart before the horse." The judge ruled that the EIR for the project was invalid due to the failure to consider the effects and requirements of the entire project.[111]

Save Our Peninsula v. Monterey County (2001)

In this case, the EIR made unsubstantiated assumptions about the amount of water which was already in use on a property. The EIR assumed the land to be currently heavily irrigated for agriculture and that conversion to housing would not constitute a major change in groundwater extraction. The administrative record however indicated minimal farming was actually occurring on the site. The decision to not consult the administrative record for the EIR was challenged in court. The California Court of Appeals held that the failure to consult the administrative record invalidated the EIR due to the flawed nature of their baseline assumptions.[112]

[110] Kibel and Epstein, "Sprawl and" Paper Water"," 21.
[111] *Stanislaus Natural Heritage Project v. County of Stanislaus*, vol. 48.
[112] Kibel and Epstein, "Sprawl and" Paper Water"," 22.

Cadiz Land Co. v. Rail Cycle (2000)

A landfill was proposed by the federal Bureau of Land Management (BLM) and San Bernardino County on land owned by the BLM. This parcel was located next to an agricultural operation. The landfill would draw water from the same aquifer which was used for agricultural purposes. Because this was a collaborative project, the BLM and the host county prepared a joint EIR/Environmental Impact Study (EIS). The owner of the agricultural operation sued to have the EIR/EIS invalidated because it did not address the amount of groundwater in the aquifer or the size of the aquifer. The plaintiff contended that this prevented the EIR/EIS from adequately considering the proposed landfill's environmental setting and potential impact on surrounding agricultural operations. The EIR/EIS was invalidated by the court of appeal when the court agreed with the plaintiff's argument. This case is important because it suggested that "agencies responsible for the preparation of such EIRs may have an affirmative duty to conduct the necessary investigation to obtain such information if it is not available at the time preparation of an EIR commences." [113] This decision would suggest that in the case of providing water supply assessments under SB 221 or 610, water suppliers would not be able to claim "no information" and make a decision with limited information. Instead they are compelled to attempt to rectify gaps in the data.

Planning & Conservation League v. Department of Water Resources (2000)

This case deals with the California Department of Water Resources (DWR) policies associated with the California State Water Project (SWP). The SWP began in the 1950s and has only been partially implemented. Given the current political, environmental and economic climate, it is highly unlikely that full implementation will occur. The full implementation was predicted to deliver 4.23 million acre feet annually and local water contractors were provided with "entitlements" equal to that amount. Currently the state is able to provide between 2-2.5 million acre feet of water annually. This case addresses the conflict over how to deal with this massive shortfall between water entitlements and *real* water supply.[114]

The Monterey Agreement (MA) was the result of negotiations over these disputes between the DWR and six local water contractors. The MA removed article 18, subdivision (b) from the long-term contractual agreement governing the State Water Project and was implemented in 1995. This

[113] Ibid.
[114] *Planning and Conservation League v. Department of Water Resources*, vol. 83.

contractual agreement subdivision governed how any long or short-term shortfall between entitlement and real water supply would be handled. The subdivision states that in the event of a long-term reduction in the real water supply, the DWR had the right to reduce all entitlements proportionately to an amount which can be provided.[115]

As part of the approval of the MA, an EIR was prepared by one of the local water contractors under the CEQA legislation. This EIR was challenged by the Planning & Conservation League as being invalid due to a failure to consider the "no change" option required by CEQA legislation. Several other points were also challenged but are not relevant for a discussion of water entitlements and land-use decisions. [116]

The EIR concluded that it was unlikely that Article 18, subdivision (b) would ever be implemented and if it was it would not affect the amount of water entitlements and did not have to be considered further. The Court of Appeals judge disagreed, instead stating that it was not the place of the EIR to consider if subdivision (b) might be implemented, and it should have instead considered the effects of if it was. The judge also disagreed with the assumption that there would be no change to entitlements if it was implemented. The judge pointed out that the reduction of entitlements to more realistic amounts had far reaching consequences in relation to land-use planning decisions. He wrote that "[p]rojects that are given the clearance to proceed based upon entitlement to X acre-feet of water might not proceed if a contractor's entitlement is reduced." And also, "[w]here land use planning determinations can be made on the basis of entitlement rather than real water, development can outpace the availability of water, leading to detrimental environmental consequences, excessive groundwater pumping, and pressure to develop additional water supplies."[117] The judge ordered the EIR invalidated due to the failure to appropriately consider the "no change" option. This was a landmark case because the judge affirmed that entitlements or "[p]aper water always was an illusion." This calls into doubt any finding of an "adequate water supply" by a water supplier which includes entitlements as part of that supply.[118]

County of Amador v. El Dorado County Water Agency (1999)

A proposed diversion of water from several lakes and rivers triggered this case. The El Dorado County Water Agency prepared the EIR to meet projected population demand from a *draft* General Plan. The

[115] Ibid.
[116] Ibid.
[117] Ibid.
[118] Ibid.

County of Amador brought suit against the water agency contending that EIRs can only be prepared for an *accepted* General Plan. The California Court of Appeal agreed. The judge wrote that the attempt by the water agency to acquire the water before the plan was approved meant that the EIR was flawed by its origins.[119] The court ruled that, "The issues become circular: water supply projects are adopted to meet growth plans outlined in a draft general plan, and the general plan is then adopted because an adequate water supply exists for the outlined development plan... An EIR predicated on a draft plan is fundamentally flawed and cannot pass CEQA muster."[120] The judgement described the proper order of events as moving from a broader plan (General Plan) to a more specific one (EIR). This is consistent with the EIR's requirement of substantiated information for decision making. A draft General Plan has no legal standing until it is approved. Allowing the EIR to consider it would be similar to allowing the EIR to consider water supplies from projects which are only "drafts."

County of Del Norte v. City of Crescent City (1999)

Crescent City had previously entered into an agreement with the surrounding county to provide water service to areas outside the city boundaries. However, it later withdrew from this agreement. The county sued the city because the county claimed that this was an attempt to force developments to join the city to obtain access to services. The higher court ruled that it was not against the law to manage growth through utilities.[121] A city's previous supply of service does not constitute an ongoing responsibility to continue to provide that service and that the service may be reduced as part of growth management or water conservation planning.[122] This case is important because it affirms that regulating growth through limiting water service is a legal tool for cities. It also frees cities from being required to continue to provide water service to unincorporated areas where they have no power to approve or deny proposed developments. While the city is reneging on its responsibilities, this decision encourages county governments to work with city governments to coordinate water supply and demand.

[119] Kibel and Epstein, "Sprawl and" Paper Water"," 23.
[120] *County of Amador v. El Dorado County Water Agency*, vol. 76, lines 950-951.
[121] *County of Del Norte v. City of Crescent City*, vol. 71, line 977.
[122] Kibel and Epstein, "Sprawl and" Paper Water"," 24.

Napa Citizens for Honest Government v. Napa County Board of Supervisors (2001)

The reliability of a future water source is addressed in this case. The final supplemental environment impact report (FSEIR) was issued for a development which found that the water source for the development would be fully allocated by 2015 and there was no clear source of additional water. The FSEIR did not address this uncertainty however and the courts ruled that, "the FSEIR also cannot simply label the possibility that they (water source) will not materialize as 'speculative,' and decline to address it."[123] The judgement in this case along with Cadiz Land Co. v. Rail Cycle, both clarify that a lack of information cannot be ignored by an EIR and a decision made without it. Instead the agency conducting the EIR must seek out the information necessary for making an informed finding.

Water Adequacy in San Luis Obispo Municipal Policies

San Luis Obispo is one of the communities that have taken concern for water adequacy the farthest in California.[124] It is the only city in California which has a General Plan Element which specifically addresses Water and Wastewater.[125] For that reason, its General Plan will be used to provide examples of how the state legislation manifests in municipal policies. The intention of SB 610 and 221 was to link land use and water supply. San Luis Obispo has instituted a comprehensive program to achieve that goal, building on the tools from the water adequacy legislation.

The municipal government is the water supplier for all areas within city limits except for the university. The city, as the water supplier, adopts a "safe annual yield," upon which all jurisdictional planning decisions rest. The "safe annual yield" is the amount of water that the city expects to be able to supply in a drought year to satisfy demand from current and future development. The city limits future development based on the expected "safe annual yield." This amount does not deplete or hinder access to water in the future and is considered to be sustainable. The total is calculated from all of the water sources that the city holds rights to, including the Salinas and Whale Rock reservoirs and groundwater. The total is calculated using the most severe drought year on record. [126]

While SB 221 and 610 only requires that developments of a certain size prove water adequacy, the city requires that all developments determine what the effect on the water supply will be. To determine

[123] *Napa Citizens for Honest Government v. Napa County Board of Supervisors*, vol. 91, lines 601-602.
[124] Odland, Belin, and Atencio, "Jemez y Sangre Water Plan Alternatives Assessment."
[125] Hanak and Simeti, "Water Supply and Growth in California," 7.
[126] "City of San Luis Obispo General Plan: Chapter 8 Water and Wastewater," 8-5, 8-6.

how much water development will require, two methods are used by the city to ensure accuracy by comparing the results. The city also has a policy that their use of groundwater for the city's water supply must not compete with agricultural interests outside the city.[127]

The City of San Luis Obispo directly links its adopted, "safe annual yield" with the amount and level of development it will permit in the municipality. This is a clear manifestation of the link between development and water supplies that the state legislature sought to achieve. San Luis Obispo's strong municipal policies demonstrate flexibility in developing alternate water sources. Developers can complete water saving retrofits to existing infrastructure and receive a portion of the water saved as credit toward their own projects.[128]

Findings

Are Senate Bill 221 and 610 adaptations?

In this section I amalgamate the four definitions of climate change adaptation previously provided. Adaptation is adjustments to systems, processes, structures, or activities which lessen vulnerability to projected or actual climate change impacts. SB 221 and 610 acts on processes, systems and activities. The stated purpose of SB 610 is to increase the reliability of California's water supply system in the face of climactic stimuli such as intensifying droughts. I conclude from this comparison that SB 221 and 610 are adaptations.

SB 221 and 610, Planned or Autonomous?

SB 221 and 610 are planned adaptations. Previous events and concern for the future precipitated the laws' conception. Senators Kuehl and Costa designed them to work in concert with the existing regulations. Both bills were planned, perhaps not perfectly but planned.

Reactive, Concurrent, or Anticipatory Adaptation

Water adequacy legislation in California is both reactive and anticipatory. SB 221 and 610, as well as local water adequacy measures, are politically feasible due to the recognition by all stakeholders (e. g.

[127] Ibid., 8-8.
[128] Ibid., 8-20.

developers, homeowners, and municipal government) that increasing demand from population growth and the declining reliability of water supplies have created a situation which demands action. These bills could be considered reactive due to their introduction after climate events brought this conflict to attention. A good example of this comes from the Hanak and Simeti survey of Californian city and county planners in 2003-2004. Surveys were sent to all county and municipal planners with a fifty eight percent response rate. One question on the survey inquired when local agencies had enacted locally-initiated water adequacy regulations. One third of the 121 responding jurisdictions, with local water adequacy requirements, enacted them during the major drought which occurred from 1987-1994.[129] While this suggests that SB 221 and 610 are reactive, I argue below that the distinction between reactive and anticipatory rests with the description of the events addressed by the legislation.

While many local-initiated water adequacy requirements are reactive adaptations, the same assumption cannot be made for SB 610. The definition of an anticipatory adaptation measure does not strictly preclude adaptations designed to target repetitive occurrences. I consider the distinction between reactive and anticipatory measures to be if it is responding solely to observed phenomenon or if it considers future changes (e.g. increasing frequency of heatwaves). SB 610 clearly states that the *frequency* and *intensity* of droughts in California is increasing and this legislation is designed to address that increase. I contend that SB 610 is an anticipatory measure because of its focus on future changes. SB 221 does not provide any information which supports a conclusion of anticipatory or reactive. However, I find it highly unlikely that two similar bills would be introduced in such close proximity to each other and have different reasons for their introduction.

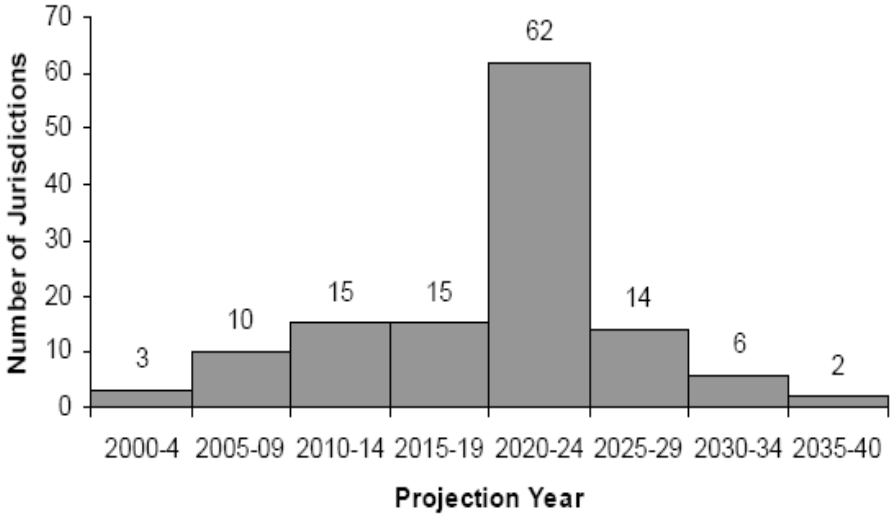
Time Horizons

Do SB 221 and 610 designate an appropriate time period for the availability of an "adequate water supply?" Both bills require a time period of twenty years. When I compare this measure to surrounding states and municipalities, twenty years is on the low end of the commonly identified spectrum.

[129] Hanak and Simeti, "Water Supply and Growth in California," 13-14.

However, when I consider Holway's argument that a strong minimum regulation set at the state level combined with the freedom for municipalities to increase that regulation, yielding the best adaptation actions, I conclude that a twenty year time period may be appropriate.[130] I do however believe that any state minimum requirement should reflect a time period which protects the state's interests. Water supply systems often extend over multiple jurisdictions and it is the state's responsibility to ensure that those jurisdictions do not impinge on each other's ability to achieve a reliable water supply. However, I found no professional opinion which addressed this question.

Figure 2 - To what year do water demand projections extend? (Reproduced from Hanak and Simeti, Water Supply and Growth in California: A Survey of City and County Land-Use Planners)



Sample size = 127
Notes: In the case of a range of years, the latest year is shown.

Figure 2 illustrates the state of water demand projections in California in 2004. Approximately two thirds of the Hanak and Simeti survey respondents, who reported having a demand projection, stated that it met the twenty year time frame required by Urban Water Management Plan legislation.[131] Almost a fifth of the respondents reported the use of a demand projection which exceeded the twenty year requirement. Only one quarter of the sample had a demand projection of less than twenty years. This survey took place only 2 years after the enactment of SB 221 and 610. Another study will be necessary to determine if the legislation's increased pressure to link development and water supply has pushed municipalities to extend their demand projections to twenty years and beyond. I conclude that due to the legislation's rigorous requirement for proof of an "adequate water supply," it is likely that

[130] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244.
[131] Hanak and Simeti, "Water Supply and Growth in California," 8.

water suppliers and municipalities will extend their demand projections out to the twenty year minimum to improve their ability to respond to water supply assessments.

Support for Data Gathering and Integration

SB 221 and 610 act in concert with earlier legislation, encouraging water suppliers to develop scientifically supportable water plans. In the case, Cadiz Land Co. v. Rail Cycle in 2000, the judge ruled that an EIR is not valid if based on insufficient data. This decision placed the burden for gathering missing data on the agency completing the EIR.

The UWMP legislation, as well as SB 221 and 610, grants entities who complete EIRs and water supply assessments, the right to recoup their costs through rate increases. This provides a supply of funding for valuable data gathering. It also places the financial burden for data gathering on the ratepayers. I consider this appropriate because if the ratepayers/public do not wish to pay the additional cost associated with new development they have legal recourse to vote decision-makers into office who can limit development and reduce costs. While SB 221 and 610 do not directly address data gathering, they do provide a mechanism for funding it and their requirement for high quality data to support water supply decisions, peripherally encourages its collection.

Factors Addressed by Adaptation Tools

While describing the characteristics of SB 221 and 610, I identified three factors to be assessed when considering the legislation. First is the spatial area to which the legislation applies (e.g. jurisdiction), the second is the type of development affected (e.g. industrial, agriculture) and the third, the size of development which triggers the regulation (e.g. 1,000 units of residential housing).

Spatial Scope of Application

California is unique in its state-wide approach to water adequacy. No other reviewed states have a state-wide program which sets a minimum time period for water supply adequacy and addresses both surface and groundwater. A state-wide policy has four major benefits. 1) It increases predictability for development across municipal jurisdictions. 2) It creates a common vocabulary of tools and expectations

for that standard. 3) It acts as a stop-gap measure, setting a state baseline from which municipalities can build locally appropriate policies. Holway, Fankhauser, Smith and Tol's opinion's support these as the most efficient types of planned adaptations.[132] And 4) the legislation applies to a large enough area that decisions concerning large-scale water infrastructure (e.g. reservoirs) and natural environmental systems can be made effectively. I conclude that SB 221 and 610 achieve all of these due to their state-wide application.

Development Types Affected

SB 221 addresses only housing developments while SB 610 applies to residential, commercial office and retail, hotels, industrial, manufacturing or processing plants, industrial parks, and mixed-use projects. SB 610 also includes a "catch-all" phrase which applies to any project which would have a similar water demand to a 500 dwelling-unit development. Holway states that industrial, municipal and commercial development is more vulnerable to climate change impacts due to their difficulty in adjusting their water demands. He identifies agricultural users as having the most flexibility to respond to changes in water supply.[133] Less capital intensive adaptation actions (e.g. altering crop species or timing, and changing irrigation practices) are the reason for this.[134] Additionally, as inefficiencies are eliminated through conservation programs in the industrial, municipal and commercial sectors, there will be less flexibility for additional reductions in water demand during shortages[135]

[132] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 244; Fankhauser, Smith, and Tol, "Weathering climate change," 68-69.
[133] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 239.
[134] Mendelsohn, "Efficient adaptation to climate change," 584.
[135] Holway, "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions," 239.

The importance of SB 221 and 610 targeting housing is illustrated in Table 2 from Hanak and Simeti's survey. Of the 138 projects reported, eighty-five percent were classified as residential or mixed use.[136] The remaining fifteen percent of commercial or industrial projects would still constitute a major draw on water supplies. While the housing requirement in SB 221 is important in targeting that 85% of projects, SB 610 is the more effective legislation due to its inclusion of developments across the spectrums.

Table 2 – Size of projects reviewed under SB 610 and SB 221 (Reproduced from Hanak and Simeti, Water Supply and Growth in California: A Survey of City and County Land-Use Planners)

Project Size	Jurisdictions	Projects
Residential/mixed use:		
- Fewer than 10 units	5	10
- 10-99 units	7	8
- 100-399 units	11	13
- 400-499	8	9
- 500 or more units	51	75
- Other a/	2	3
Commercial/industrial	15	20

Sample size = 307

a/ includes residential projects with other size indicators (e.g., acres).

Development Size for Regulation Application

In the Hanak and Simeti survey, in a sample size of 157 county and city governments, 131 reported legislation which set a threshold of a single dwelling-unit to trigger a review of the project's water adequacy. Only five of the surveyed governments used the state-set threshold of 500 units or greater. Many local governments clearly believe it is important to consider projects smaller than 500 dwelling-units or its equivalent when considering water adequacy. Table 2 illustrates that of 138 projects, fifty four percent exceeded the 500 unit threshold. From this survey's result, I extrapolate that approximately fifty percent of development projects in California are captured by the state regulation.[137] This is a sobering statistic because in 2004, when the survey was taken, one tenth of the communities which conducted reviews since SB 221 and 610 were passed, had no local review requirement of their own.[138] It indicates that local governments are not consistently enacting complementary local regulations, weakening state water supply planning. I conclude that unless further studies identify an

[136] Hanak and Simeti, "Water Supply and Growth in California," 18-19.
[137] Ibid., 13, 18-19.
[138] Ibid., 21.

increase in the number of more stringent local review requirements, SB 221 and SB 610 set too high a standard for triggering a review of water adequacy.

Flexibility

When working with complex systems such as water, there are always unknowns. Flexibility is integral to addressing new and unexpected phenomena. As I discussed in the literature review, there are many areas in water supply planning where it is important for adaptations to be flexible. However, because SB 221 and 610 do not deal directly with water supply provision, most of these are not applicable. I did identify one area where the legislation functions in a flexible manner, due to its frequent five-year review requirement. This requirement supports reconsideration and frequent adjustments of the water system's components, contributing to the system's flexibility. However, the legislation does not address the possibility that the existing water supply might not be able to supply current users and this blind spot weakens its flexibility.

Conclusion

SB 610 and SB 221 have the potential to be strong climate change adaptation tools. I can make no supportable conclusion regarding their effectiveness at this time, though their potential is clear. If SB 221 and 610 were fully implemented by all Californian authorities there would be far greater coordination between development and water supplies. All large water suppliers would have twenty-year water supply plans. The plans would be reviewed every five years to take into account changing conditions. All decisions related to water supplies would be supported by reliable data and that data would improve the understanding of the state's surface and groundwater resources. Local governments approving all types of large development applications would consult with the applicable water service provider to determine if a reliable long-term water supply is available. More stringent water adequacy requirements would be enacted by local governments based on their water supply situation.

However this is not the reality of the situation. Implementation of the legislation has suffered at the local government and water supplier level. One third of water suppliers do not have the required

twenty year water supply plans.[139] While some municipalities such as San Luis Obispo have gone far beyond what the regulation requires, ten percent of local governments have no additional water adequacy requirement.[140]

There has been support for water adequacy legislation by the courts in California. In County of Del Norte v. City of Crescent City, the court supported the practice of using water services to regulate growth. The Planning & Conservation League v. Department of Water Resources ruling struck at the heart of the business-as-usual use of entitlements. Unfortunately, despite this support from the courts, the impacts of climate change on California will occur soon and adaptation must happen immediately. The lack of enforcement of the legislation by state authorities leaves California vulnerable.

The current implementation of the water adequacy legislation does not go far enough to deal with climate change impacts. The state of California should revise its water adequacy legislation to incorporate the following points to overcome the serious vulnerability of its water supply.

Changes to the legislation must:

- increase penalties for failing to comply with the legislation.
- introduce a monitoring program that tracks the following factors:
    1. the number of projects captured by the state's standard
    2. the number of municipalities with additional water adequacy requirements
    3. the effectiveness of the twenty year requirement in assisting with water supply provision and planning
- force local governments to cap development based on water supplies.
- prohibit aquifer overdrafting
- prohibit use of water entitlements, unlikely to be fulfilled, to determine water adequacy.
- expand the requirement for a "water adequacy review" to include all new development undertaken in the state

I conclude that only through the full implementation of SB 221 and 610, as well as the addition of these policies, can California hope to address its serious climate change impacts on water resources.

[139] Ibid., 8.
[140] Ibid., 21.

Bibliography

Adaptation to Climactic Variability and Change. Guelph: Environment Canada, 1993.

Bureau of Land Management. "Western States Water Laws - California." http://www.blm.gov/nstc/WaterLaws/california.html.

Burton, Ian, Joel B. Smith, and Stephanie Lenhart. "Chapter 5: Adaptation to Climate Change: Theory and Assessment." In *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*, edited by Jan F. Feenstra, Ian Burton, Joel B. Smith, and Richard S. J. Tol, 464. 2nd ed. United Nations Environment Programme and the Institute for Environmental Studies, 1998. http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/465/Global_Methods_for_CC_Assessment_Adaptation_-_UNEP_1998.pdf.

California Public Resources. *California Public Resources Code*. http://www.leginfo.ca.gov/cgi-bin/displaycode?section=prc&group=20001-21000&file=21000-21006.

California Water Act. *California Water Code*. http://www.leginfo.ca.gov/cgi-bin/displaycode?section=prc&group=20001-21000&file=21000-21006.

California Water Act. *California Water Code*. http://www.leginfo.ca.gov/cgi-bin/displaycode?section=wat&group=10001-11000&file=10620-10621.

California Water Act. *California Water Code*. http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=wat&codebody=&hits=20.

"City of San Luis Obispo General Plan: Chapter 8 Water and Wastewater," April 4, 2006. http://www.ci.san-luis-obispo.ca.us/communitydevelopment/download/5-15-07%20Unified%20GP/chapter8waterandwastewater.pdf.

Cooley, Heather, Juliet Christian-Smith, and Peter Gleick. *Sustaining California Agriculture in an Uncertain Future*. Oakland, CA: Pacific Institute, July 2009. http://www.pacinst.org/reports/california_agriculture/final.pdf.

County of Amador v. El Dorado County Water Agency, 76 Cal. App. 4th 931 (Cal: Court of Appeal, 3rd District 1999).

County of Del Norte v. City of Crescent City, 71 Cal. App. 4th 965 (Cal: Court of Appeal, 1st District 1999).

Department of Finance. *Census 2000: Summary File 1 California Profile.* Sacramento, CA: State of California, August 2002. http://www.dof.ca.gov/research/demographic/reports/census-surveys/summary_file_1_california_profile/documents/Census2000CA_profile.doc.

———. *Population Projections for California and its Counties 2000-2050, by Age, Gender and Race/Ethnicity*. Population Growth Projection. Projection Series. Sacramento, CA: State of California, July 2007. http://www.dof.ca.gov/research/demographic/reports/projections/p-3/documents/CALIFORNIA.XLS.

Fankhauser, Samuel, Joel B. Smith, and Richard S. J. Tol. "Weathering climate change: some simple rules to guide adaptation decisions." *Ecological Economics* 30, no. 1. Ecological Economics (1999): 67-78.

Hanak, E. *Water for growth: California's new frontier*. Public Policy Instit. of CA, 2005.

Hanak, E., and A. Simeti. "Water Supply and Growth in California: A Survey of City and County

Land-Use Planners." *Public Policy Institute of California* (March 15, 2004): 28.
Hanak, Ellen. "Finding Water for Growth: New Sources, New Tools, New Challenges." *JAWRA Journal of the American Water Resources Association* 43, no. 4 (2007): 1024-1035.
Hanak, Ellen, and Margaret K. Browne. "Linking Housing Growth to Water Supply: New Planning Frontiers in the American West." *Journal of the American Planning Association* 72, no. 2 (2006): 154.
Hanak, Ellen, and Ada Chen. "Wet Growth: Effects Of Water Policies On Land Use In The American West." *Journal of Regional Science* 47, no. 1. Journal of Regional Science (2007): 85-108.
Holway, Jim. "Adaptive Water Quantity Management: Designing for Sustainability and Resiliency in Water Scarce Regions." In *The Water Environment of Cities*, edited by Lawrence Baker, 235-258. Springer Science+Business Media, LLC, 2009. http://www.jlakes.org/book/WATER-ENV-CITY/fulltext%2824%29.pdf.
Intergovernmental Panel on Climate Change, I. P.O.C. "Climate change 2007: Impacts, adaptation and vulnerability Summary for Policymakers." *Contribution of the Working Group II to the Fourth Assessment report of the Intergovernmental Panel on Climate Change* (2007): 22.
Kibel, P. S, and B. H Epstein. "Sprawl and" Paper Water": A Reality Check from the California Courts." *California Real Property Journal* 20, no. 1/2 (2002): 21-27.
Loaiciga, H. A, J. B Valdes, R. Vogel, J. Garvey, and H. Schwarz. "Global warming and the hydrologic cycle." *Journal of Hydrology* 174, no. 1-2 (1996): 83–127.
McKinney, Matthew. "Linking Growth and Land Use to Water Supply." *Land Lines*, April 2003.
Mendelsohn, R. "Efficient adaptation to climate change." *Climatic Change* 45, no. 3 (2000): 583–600.
Napa Citizens for Honest Government v. Napa County Board of Supervisors, 91 Cal. App. 4th 342 (Court of Appeal of California, First Appellate District, Division One 2001).
National Oceanic and Atmospheric Administration. "Description of Hydrologic Cycle." *Northwest River Forecast Center*. http://www.nwrfc.noaa.gov/info/water_cycle/hydrology.cgi.
Odland, Robert, Alletta Belin, and Ernest Atencio. "Jemez y Sangre Water Plan Alternatives Assessment." Daniel B. Stephens & Associates, Inc., 2002. http://www.ose.state.nm.us/water-info/NMWaterPlanning/regions/MiddleRioGrande/App12-13-1-JyS-ManageGrowthLandUse.pdf.
Planning and Conservation League v. Department of Water Resources, 83 83 Cal. App. 4th 892 (California Court of Appeal, 3rd Appellate District 2000).
"Restoration Economics: Discounting and Time Preference." Government. *NOAA Coastal Services Center*. http://www.csc.noaa.gov/coastal/economics/discounting.htm.
Senator Costa. *Water Supply Planning*. *Public Resources Code and the Water Code*, 2001. http://info.sen.ca.gov/pub/01-02/bill/sen/sb_0601-0650/sb_610_bill_20011009_chaptered.html.
Senator Kuehl. *Land Use: water supplies*. *Business and Professions Code and the Government Code*, 2001. http://info.sen.ca.gov/pub/01-02/bill/sen/sb_0201-0250/sb_221_bill_20011009_chaptered.html.

Smit, Barry, Ian Burton, Richard J.T. Klein, and J. Wandel. “An Anatomy of Adaptation to Climate Change and Variability.” *Climatic Change* 45, no. 1 (April 1, 2000): 223-251.

Stakhiv, E. *Evaluation of IPCC Adaptation Strategies*. Draft. Fort Belvoir, VA: Institute for Water Resources; U.S. Army Corps of Engineers, 1993.

Stanislaus Natural Heritage Project v. County of Stanislaus, 48 Cal. App. 4th 182 (Court of Appeal of California, Fifth Appellate District 1996).

State of California General Plan Guidelines. Governor's Office of Planning and Research, 2003. http://www.opr.ca.gov/planning/publications/General_Plan_Guidelines_2003.pdf.

Stzepak, Kenneth M., Max Campos, Zdzislaw Kaczmarek, Arturo Sanchez, and David N. Yates. “Chapter 6: Water Resources.” In *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*, edited by Jan F. Feenstra, Ian Burton, Joel B. Smith, and Richard S. J. Tol, 464. 2nd ed. United Nations Environment Programme and the Institute for Environmental Studies, 1998. http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/465/Global_Methods_for_CC_Assessment_Adaptation_-_UNEP_1998.pdf.

“The Colorado Compact,” 1922. http://www.usbr.gov/lc/region/pao/pdfiles/crcompct.pdf.

Urban Water Management Act. *California Water Code*. http://www.leginfo.ca.gov/cgi-bin/displaycode?section=wat&group=10001-11000&file=10610-10610.4.

Wallace, Chris. “The Thames Barrier - A Systems Study,” May 2005. http://www.cems.uwe.ac.uk/~cjwallac/CPDA_SE/thamesbarriercase.htm.

Waterman, R. “Addressing California's Uncertain Water Future by Coordinating Long-Term Land Use and Water Planning: Is a Water Element in the General Plan the Next Step.” *Ecology LQ* 31 (2004): 117.

Watson, R. T, M. C Zinyowera, R. H Moss, and D. J Dokken. *Climate change 1995: impacts, adaptations and mitigation of climate change: scientific-technical analyses*. Cambridge University Press Cambridge, 1996.