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Symposium: Continuing to Fight Today's Environmental Challenges: Climate Change, Health Concerns, Energy, and Food Supply

California Adapts to Prolonged Drought: Any Lessons for the Humid Midwest?

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CALIFORNIA ADAPTS TO PROLONGED DROUGHT: ANY LESSONS FOR THE HUMID MIDWEST?

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I. INTRODUCTION: CALIFORNIA DRIES OUT

Since 2012, California has been adapting to a severe, periodic drought.[1] The state has coped with severe droughts for decades, but the current, on-going drought has three characteristics that differentiate it from past episodes. First, it has lasted longer and been more severe, especially for rural areas and the environment.[2] Second, this is the first drought since the economic and social adverse impacts of anthropocentric global climate change ("GCC") have been widely accepted by both state water managers and the general population.[3] "A continuation of this warming trend into the future will cause more moisture losses and push California into a state of persistent aridity. By around 2060 California may be experiencing something akin to a permanent drought."[4] Third,

* A.B. 1962, LL.B., 1965, Stanford University. University Distinguished Professor Emeritus, Illinois Tech, Chicago-Kent College of Law. This Article was written before the recording-setting La Niña winter of 2016–17 which led Governor Jerry Brown to declare the drought officially over. However, California's long-term water problems are not over.

1 *See generally* Noah S. Diffenbaugh et al., *Anthropocentric Warming Has Increased Drought Risk in California*, 112 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 3931 (2015) (exploring the drought in California).

2 *See U.S. Drought Monitor: California*, NAT'L DROUGHT MITIGATION CTR. (2016), http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?CA [https://perma.cc/M7YK-FV6E] (expressing the impact of the drought in California). The 2012–2015 drought is the highest measured drought, as indicated by the leading drought research center at the University of Nebraska, Lincoln. *Id*.

3 *See Climate Change in the American Mind: Focus on California, Colorado, Ohio, and Texas*, YALE (Oct. 2, 2015), http://environment.yale.edu/climate-communication/files/California_Colorado_Ohio_Texas_Climate_Change_Report.pdf [https://perma.cc/DZ4B-XKY4] (finding seventy-nine percent of Californians polled believe that global warming is happening, and fifty-eight percent believe that it is caused by human activity). In addition, fifty-five percent of Californians responded that they have personally experienced the effects of climate change. *Id*. The numbers in all categories for the other three states are lower. *Id*.

4 Don Hofstrand, *Impact of California's Drought on its Agriculture*, AGRIC. MKTG. RES. CTR. (Aug. 2015), http://www.agmrc.org/renewable_energy/climate_change/impact-of-californias-drought-on-its-agriculture/ [https://perma.cc/N4BT-QPPG] (illustrating how, due to global climate change ("GCC"), heavy moisture intervals may be insufficient to end a prolonged drought). In the 2015–2016 winter, the Sierra Nevada mountain range received eighty-seven percent of its normal moisture. *See* Henry Fountain, *Sierra Nevada Snow Won't End California's Thirst*, N.Y. TIMES (Apr. 11, 2016), http://www.nytimes.com/2016/04/12/science/california-snow-drought-sierra-nevada-water.html?_r=1 [https://perma.cc/34XC-XW53] (discussing the impact of climate change on California). However, in April 2016, an evaluation of the snowpack confirmed the GCC scenario: more moisture fell as rain,

government and private responses have been more dynamic and stringent compared to past droughts.[5] In the past, the primary strategy was to conserve some urban water, pump groundwater to make up for surface supply deficits, and wait for next wet El Niño cycle.[6]

This Article surveys the steps California took to adapt between 2012–2015.[7] It argues that the broader lessons of the 2012–2015 mega-drought are: (1) that the state's dams and increased groundwater pumping enabled it to limp through the drought, but only at increasing environmental and social costs; and (2) that this muddling through strategy is no longer sustainable.[8] The state's responses are important and

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rather than snow, resulting in less runoff. *Id*. As a result, because of the drought, warmer winters have stressed forests, the trees do not go dormant in the winter, and they consume more of the runoff. *Id*.

5 *See* Kirk Siegler, *Coping in a Drier World: California's Drought Survival Strategy*, NPR (Oct. 22, 2014), http://www.npr.org/2014/10/22/358096112/coping-in-a-drier-world-californias-drought-survival-strategy [https://perma.cc/RX53-3JV5] (comparing previous responses to the drought with new responses).

6 *See* Hofstrand, *supra* note 4 (discussing previous primary strategies California has used during times of drought).

7 *See infra* Parts II, IV (examining both California's and the Midwest's adaptation to climate change). California's adaptation is a dynamic, on-going, and multi-actor process. *See infra* Part II (elucidating on the effects of the drought in California, as well as the various adaptations taken). The focus of this Article is on the responses taken in 2014 and 2015, but selective 2016 developments have also been included. *See infra* Part III (analyzing the different approaches available to combat the drought).

8 *See* Charles Fishman, *How California is Winning the Drought,* N.Y. TIMES (Aug. 14, 2015), http://www.nytimes.com/2015/08/16/opinion/sunday/how-california-is-winning-the-drought.html?_r=0 [https://perma.cc/A8G5-T2N3] (reporting that initially, groundwater pumping made up seventy-seven percent of the federal water delivery cutbacks, but the percentage fell to seventy-one percent in 2015, throwing into question the sustainability of this strategy that California agriculture has continued to utilize during the drought); Ellen Hanak & Jeffrey Mount, *A California Drought Report Card*, PUB. POL'Y INST. OF CAL. (Apr. 11, 2016), http://www.ppic.org/main/blog_detail.asp?i=2010 [https://perma.cc/PKL8-DZZ5] (giving municipal responses an A-, farmers' responses a B, but giving the state's response to rural shortages and the environment a C- and D respectively); *see also Thirsting for Progress: A Report Card on California's Responses to the Drought*, NAT. RES. DEF. COUNCIL 2 (Dec. 2015), http://www.nrdc.org/water/california-droufght-response.asp [https://perma.cc/QVW8-TSLE] [hereinafter *Thirsting for Progress*] (grading the state on five criteria: (1) urban water conservation and efficiency; (2) agricultural water conservation and efficiency; (3) storm water capture and reuse; (4) water recycling and reuse; and (5) restoring the San Francisco Bay-Delta Estuary). The respective grades were B, D, D, B-, and F. *Thirsting for Progress*, *supra* note 8, at 20. Two respected water experts graded the state marginally better in 2016 on slightly different criteria. *See generally Impact of the Drought in the San Joaquin Valley of California*, CAL. ST. U. (July 2015), http://www.fresnostate.edu/academics/drought/documents/Fresno%20State-Drought%20Study_Minus20%Executivee%208 Summary-FINAL.pdf [https://perma.cc/EV7S-52JR] (citing studies that ignore the adverse impacts on low-income farmworkers and the aquatic environment); Alvar Escriva–Bou & Henry McCann, *Three Lessons on Water Accounting for California*, PUB. POL'Y INST. OF CAL.

far-reaching compared to past droughts, but such responses may not be adequate to cope with a permanent GCC-altered climate in a water-vulnerable state such as California.[9] Then, this Article asks what, if any, lessons the California experience has for the Midwest, which will experience GCC, but not on the scale or intensity compared to more arid areas.[10]

II. CALIFORNIA: A MIDWESTERN LIFESTYLE IN A VARIABLE MEDITERRANEAN CLIMATE

A. The Geo-Hydrological Setting

Nature played a cruel trick on California, giving the state's coastal areas a mild, Mediterranean climate, which has created an economy based on creativity and leisure.[11] Nature also gave the state a great semi-arid inland valley and desert areas suitable for high value, irrigated crops.[12] Humans have both appreciated and abused nature's gift. The Midwestern settlers who created modern southern California were attracted by the mild climate, but they imposed green Midwestern landscape on a desert that faces an ocean.[13] In the Central Valley, farmers turned to irrigated agriculture after the nineteenth century cattle and grain economies collapsed.[14] Today, in spite of its variable climate, California produces one-half of the fruits, vegetables, and nuts grown in the United States, as well as almost ninety percent of the domestically produced wines, and is the world's eighth largest economy.[15]

(Aug. 8, 2016), http://www.ppic.org/main/blog_detail.asp?i=2102 [https://perma.cc/WVE3-TM7K] (recommending steps California may take to adapt to the drought).

9 *See infra* Parts I, II (discussing the state's progress and how more progress is needed).

10 *See infra* Parts III, IV (providing lessons regarding GCC to the Midwest based on California's experience).

11 *See generally* KEVIN STARR, AMERICANS AND THE CALIFORNIA DREAM 1850–1915 (1973) (showing how historian Kevin Starr traces the evolution of California and its neo-Mediterranean economy and culture in his multiple volume history of the Golden State); KEVIN STARR, INVENTING THE DREAM: CALIFORNIA THROUGH THE PROGRESSIVE ERA (1985) (describing California's agricultural economy and its impact on the local environment).

12 *See California Precipitation*, WATER.CA.GOV (Sept. 23, 2016), http://www.water.ca.gov/floodmgmt/hafoo/csc/docs/CA_Precipitation_2pager.pdf [https://perma.cc/22U4-J3P5] (describing how nature provides California with half of its annual precipitation from December through February).

13 CAREY MCWILLIAMS, SOUTHERN CALIFORNIA COUNTRY: AN ISLAND IN THE LAND 97 (1946).

14 *See generally* WILLIAM PRESTON, VANISHING LANDSCAPES: LAND AND LIFE IN THE TULARE BASIN (1981) (relaying how farmers used irrigation with cattle and grain economies in the nineteenth century).

15 *See* Jason Sisney & Justin Garosi, *2014 GDP: California Ranks 7th or 8th in the World*, LEGIS. ANALYST'S OFF. (July 1, 2015), http://www.lao.ca.gov/LAOEconTax/Article/Detail/

The net result placed people and high water-demanding crops in places without reliable, adequate supplies to sustain them.[16] To add insult to injury, the rainfall and snowpack necessary to sustain the Central Valley and urban southern California are concentrated in the less populated northern areas of the state.[17] Thus, the state is highly vulnerable to the adverse impacts of GCC because it is a wetter, warmer climate with less net water availability.[18]

California's leaders have always known that the state is vulnerable to drought, but have proceeded on the assumption that science and engineering can outwit nature.[19] The state has buffered both farmers and urban residents from the adverse consequences of periodic droughts by building a series of dams, reservoirs, irrigation canals, and aqueducts to bring water from northern California to the Central Valley and urban southern California.[20] Aqueducts first brought water from the eastern slope of Sierra Nevada Mountains and the Colorado River to urban

90 [https://perma.cc/7245-YU8F] (stating California's gross domestic product ("GDP") rankings range from seventh to eleventh).

16 *See Climate Impacts in the Southwest,* EPA (Oct. 6, 2016), https://www.epa.gov/climate-impacts/climate-impacts-southwest [https://perma.cc/L9S8-AKDE] (observing that climate change in California will place additional stress on the state due to the state's expected population growth).

17 *See id.* (identifying the Central Valley as one of the most fruitful agricultural regions in the entire United States).

18 *See* CALIFORNIA DEPARTMENT OF WATER RESOURCES, MANAGING AN UNCERTAIN FUTURE 3 (2008) (explaining the effort to separate "normal" weather explanations for events from GCC explanations is an on-going project and subject of considerable scientific dispute; however, more studies identify a GCC component of an extreme weather event); *American Meteorological Society Explaining Extreme Events of 2014 from a Climate Perspective*, 96 BULL. OF THE AM. METEOROLOGICAL SOC'Y No. 12 (Dec. 2015) (explaining how scientists estimate that 20% of the 2012–2015 prolonged drought is the result of the projected impacts of GCC on water); A. Park Williams et al., *Contribution of Anthropogenic Warming to California Drought During* 2012–2014, 42 GEOPHYSICAL RES. LETTERS 6819 (providing that the drought can be tracked month-by-month on a series of drought index maps); Kyle Kim & Thomas Suh Lauder, *249 Drought Maps That Show Just How Thirsty California Has Become* (Sept. 26, 2016), http://www.latimes.com/science/la-me-g-california-drought-map-htmlstory.html [https://perma.cc/48WD-2KTB] (depicting how serious the drought problem in California has become over the years).

19 *See* Peter Folger et al., *Drought in the United States: Causes and Issues for Congress*, CONG. RES. SERV. 23 (Apr. 22, 2013), https://www.fas.org/sgp/crs/misc/RL34580.pdf [https://perma.cc/PK9P-FNYJ] (observing drought conditions as slow developing, which makes them hard to predict even with technology).

20 *See generally* DONALD PISANI, FROM THE FAMILY FARM TO AGRIBUSINESS: THE IRRIGATION CRUSADE IN CALIFORNIA (1984); MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER Ch. 6 (1986); WILLIAM WARNE, THE BUREAU OF RECLAMATION (1973); *see also Southern California Water–Essays in Honor of Norris L. Huntley, Jr.*, 27 J. WESTERN LEGAL HIST. 121–238 (2014) (explaining that the federal government's construction of dams in the Sierra Nevada Mountains and at the headwaters of the Sacramento and Trinity Rivers brought water to the Central Valley—especially the San Joaquin Valley).

southern California, then water was moved from far northern California to the Central Valley and Los Angeles.[21]

Water law also contributed to the illusion of water security. The state's complex, unique water allocation law, developed in the late nineteenth and early twentieth centuries, encouraged large-scale water use and provided almost no incentives to conserve water.[22] For over 100 years, the law has allowed large water users to rely on carry-over storage and unregulated groundwater pumping with little risk of the enforcement of priorities or challenges to the reasonableness of riparian uses.[23]

B. Drought Adaptation: Waiting for El Niño

Drought is a "slow-moving" disaster compared to floods, earthquakes, and forest fires.[24] Society's views of droughts have evolved over time from a punishment to a condition that can be mitigated by human action.[25] As the Israelites were about to enter the Promised Land, we read in the Bible that God cursed them with drought: "I will make the sky above you as hard as iron, and your soil as hard as bronze, so that your strength shall be spent in vain; your land will bear no crops, and its trees no fruit."[26] We now understand that disasters such as droughts are not acts of divine retribution, but a combination of natural events and

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21 *See, e.g.*, NORRIS HUNDLEY, THE GREAT THIRST: CALIFORNIANS AND WATER, A HISTORY 246–47 (Rev. ed. 2001) (explaining California's reallocation of water); KEVIN STARR, MATERIAL DREAMS: SOUTHERN CALIFORNIA THROUGH THE 1920S 3–4, 45 (1990) (identifying the change in water diversion patterns from Southern California to Central California); Michael Hanemann et al., *California's Flawed Surface Water Rights, in* SUSTAINABLE WATER: CHALLENGES AND SOLUTIONS FROM CALIFORNIA 68 (A. Lassiter ed., 2015) (examining the Central Valley Project, which diverted water to Southern California).

22 *See* ELLEN HANAK ET AL., MANAGING CALIFORNIA'S WATER: FROM CONFLICT TO RECONCILIATION 22, 27, 31 (2011), http://www.ppic.org/content/pubs/report/R_211EHR.pdf [https://perma.cc/WF46-T9CF] (providing a history of California's water rights and overuse of water).

23 *See id*. at 23 (comparing the types of water rights historically held in California); *see also* Kate Campbell, *California Groundwater: Resource Remains Vast but Difficult to Define Fully*, SIERRA SUN TIMES (Oct. 14, 2015), http://goldrushcam.com/sierrasuntimes/index.php/news/local-news/4938-california-groundwater-resource-remains-vast-but-difficult-to-define-fully [https://perma.cc/E8PQ-6K4L] (supporting the author's proposition that relying on carry-over storage and groundwater is not irrational because estimates of the state's groundwater reserves run from 850 million to 1.3 billion acre-feet, compared to the 11.8 million acre-feet stored in Central Valley Project reservoirs).

24 *See* Folger et al., *supra* note 19, at 23 (describing drought conditions as slow developing and unpredictable).

25 *See* Lisa Grow Sun, *Climate Change and the Narrative of Disaster*, *in* THE ROLE OF INTERNATIONAL ENVIRONMENTAL LAW IN DISASTER RISK REDUCTION 29–33 (Jacqueline Peel and David Fisher eds., 2016) (illustrating the shift from a God-blaming approach to a human-blaming approach for natural disasters).

26 *Leviticus* 26:19–20.

human choice.[27] However, the Biblical view occasionally surfaces; California's drought has been characterized as divine retribution for the state's tolerance for same sex marriages and abortion.[28]

Drought is defined both conceptually and operationally. Conceptually, "[d]rought is a protracted period of deficient precipitation resulting in extensive damage to crops, resulting in loss of yield."[29] Operational definitions rely on indices to measure commencement, duration, and impact.[30] For example, "[t]o determine the beginning of drought, operational definitions specify the degree of departure from the average of precipitation or some other climatic variable over some time period. This is usually done by comparing the current situation to the historical average, often based on a 30-year period of record."[31]

Drought adaptation is necessary because the rain and snow in California fall mainly in the winter.[32] Thus, the state is a captive of the Southern Oscillation, which produces La Niña and El Niño years.[33] El

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[27] *See* BEN WISNER ET AL., AT RISK: NATURAL HAZARDS, PEOPLE'S VULNERABILITY AND DISASTERS 4 (2d ed. 2003) (declaring human actions have a causative effect on natural disasters); *see also* WORLD BANK, NATURAL HAZARDS, UNNATURAL DISASTERS: THE ECONOMIES OF EFFECTIVE PREVENTION 1 (2010) (explaining that disasters can be assessed economically by viewing the effects of people's choices).

[28] *See* Zoe Greenberg, *California Assemblywoman: Drought Represents God's Wrath over Abortion*, REWIRE (Jun. 10, 2015), https://rewire.news/article/2015/06/10/california-assemblywoman-drought-represents-gods-wrath-abortion/ [https://perma.cc/2GNS-MTYP] (explaining a Texas Assemblywoman's view on the biblical origin of the California drought). In 2015, a conservative California Assembly member pronounced that "Texas was in a long period of drought until Governor Perry signed the fetal pain bill," which included a twenty week ban on abortions, and stated further "[i]t rained that night. Now God has His hold on California." *Id.*

[29] *What Is Drought?*, NAT'L DROUGHT MITIGATION CTR. (2016), http://drought.unl.edu/DroughtBasics/WhatisDrought.aspx [https://perma.cc/E8PQ-6K4L].

[30] *See id.* (explaining the use of operational definitions of drought).

[31] *Id.*

[32] *See California Precipitation*, CAL. DEP'T OF WATER RES., http://cnap.ucsd.edu/pdffiles/CA_Precip_final.pdf [https://perma.cc/JW6K-F677] (describing how fifty percent of the annual precipitation in California occurs from December to February).

[33] *See What Is La Niña?*, CONSERVE ENERGY FUTURE (2016), http://www.conserve-energy-future.com/what-is-la-Niña.php [https://perma.cc/38FT-RLDF] (comparing the climatic effects of El Niño and La Niña). When high pressure builds over the eastern equatorial Pacific, the sea-level pressures that drive the Trade Winds decrease and the water warms, producing La Niña. *Id. See also* Bob Henson, *El Niño, La Niña & ENSO FAQ*, U. CORP. FOR ATMOSPHERIC RES. (2014), https://www2.ucar.edu/news/backgrounders/el-Niño-la-Niña-enso-faq [https://perma.cc/NA6G-YPSY] (explaining the origin of the terms El Niño and La Niña). In brief, the normal tropical Trade Wind pattern pushes cold water toward the Pacific Coasts of North and South America, which was named La Niña by researchers because its climate patterns are opposite of El Niño. *See What is La Niña?*, *supra* note 33 (identifying the relationship between El Niño and La Niña); David B. Enfield, *El Niño: Oceanic and Climatic Phenomenon*, ENCYCLOPEDIA BRITANNICA (Sept. 25, 2016), https://www.britannica.com/science/El-Niño [https://perma.cc/3ZB2-4P8K] (explaining the normal patterns and effects

Niño means that warm water in the Pacific Ocean will produce a stormy winter with rain and heavy snow, with the risk of serious flooding.[34] La Niña means that cold water in the Pacific produces a meager winter and rainy season; thus, a drought.[35] Both "children" can "act out" for several years, but in general, the La Niña cycle lasts longer than her brother.[36]

Because the occurrence of a drought is more predictable, as compared to an earthquake, adaptation can occur in advance and throughout a drought.[37] Thus, a state can adopt a menu of proactive and reactive strategies.[38] California's drought adaptation strategies have been primarily proactive, and have been technology and science-based.[39] However, California is now using more reactive water use management during the drought, by both urban and agricultural users.[40] Proactive adaptation has primarily consisted of the construction of a water storage and delivery infrastructure to store and deliver adequate supplies during a drought.[41] The primary reactive strategies are short-term conservation measures, the use of alternative supplies, water banks, land fallowing, and

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of El Niño). Today, El Niño refers to an extensive warming across the central and equatorial Pacific that lasts for three or more seasons. *Id.*

34 *See* Rong-Gong Lin II & Rosanna Xia, *Massive El Niño Gains Strength, Likely to Drench Key California Drought Zone*, L.A. TIMES (Nov. 20, 2015), http://www.latimes.com/local/weather/la-me-ln-el-Niño-q-a-20151120-story.html [https://perma.cc/L5GD-DQST] (demonstrating El Niño's impact on weather patterns).

35 *See What is La Niña?*, *supra* note 33 (stating the climatic effects of La Niña).

36 *See* Henson, *supra* note 33 (comparing the durations of El Niño and La Niña).

37 *See Drought–Technical Hazard Sheet–Natural Disaster Profiles*, WORLD HEALTH ORG. (2016), http://www.who.int/hac/techguidance/ems/drought/en/ [https://perma.cc/9HMN-X9SG] (examining a drought's predictable nature).

38 *See* Donald A. Wilhite et al., *Managing Drought Risk in a Changing Climate: The Role of National Drought Policy*, 3 WEATHER AND CLIMATE EXTREMES 4, 7–8 (2014) (explaining different types of proactive and reactive strategies).

39 *See, e.g.*, Louise Jackson et al., *Adaptation Strategies for Agricultural Sustainability in Yolo County, California*, CAL. NAT. RES. AGENCY (July 2012), http://www.energy.ca.gov/2012publications/CEC-500-2012-032/CEC-500-2012-032.pdf [https://perma.cc/E8R6-VZ88] (revealing the decrease in water demand resulting from new irrigation technology).

40 *See* Ruth Langridge, *Climate Change and Water Supply Security: Reconfiguring Groundwater Management to Reduce Drought Vulnerability*, CAL. ENERGY COMMISSION (July 2012), http://www.energy.ca.gov/2012publications/CEC-500-2012-017/CEC-500-2012-017.pdf [https://perma.cc/6UND-58XQ] (stating that state guidelines and drought adaptations in California have traditionally been reactive); *see also* Daniel K. Macon et al., *Coping with Drought on California Rangelands*, SOC'Y FOR RANGE MGMT. 225 (2016), http://ac.els-cdn.com/S019005281630027X/1-s2.0-S019005281630027X-main.pdf?_tid=09f99014-8667-11e6-b4de-00000aacb362&acdnat=1475168959_f55146143a9c9e86881099e72ab20655 [https://perma.cc/9GWP-RLBG] (stating the most popular agricultural proactive strategies are focused on flexibility and minimizing potential vulnerability to reduced forage availability).

41 *See, e.g.*, Wilhite et al., *supra* note 38, at 8 (listing drought mitigation strategies such as early warning systems and utilizing ground water resources).

new scientific advances, such as switching to drought resistant crops or landscapes, to tough it out until the next El Niño cycle arrives.[42] In short, temporary adaptation during the drought has been favored over more fundamental land and water use choices, which can be a non-sustainable strategy because the state must live within its GCC-stressed existing water budget.[43]

Californians follow the Southern Oscillation with the devotion of die-hard National Football League ("NFL") fans who look for every scrap of news that suggests a good season.[44] Unfortunately, reliance on the eventual return of an El Niño cycle is becoming an unrealistic adaptation strategy.[45] A mediocre wet year guarantees quick relief, but many experts predict that drought cycles are likely to be longer and more severe.[46] Therefore, an El Niño rainy season will provide some drought relief, but the rain and snow may not be enough to end the drought deficit, as appears to be the case with the state's wet 2015–2016 winter.[47] Thus, El Niño years now have a serious, long-term downside for a GCC-based water policy. Given the extensive evidence and the fact that most people do not grasp long-term, abstract risks such as climate change, an El Niño rainy season lures the population into believing that the drought is over,

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42 *See, e.g.*, Scott Malcom et al., *Agricultural Adaptation to a Changing Climate: Economic and Environmental Implications Vary by U.S. Region*, U.S. DEP'T OF AGRIC. iv, 2 (July 2012), http://www.ers.usda.gov/media/848748/err136.pdf [https://perma.cc/JPV9-3B7S] (describing agricultural adaption strategies).

43 *See, e.g.*, Cal. Exec. Order No. B-29-15 (2014) (imposing a reduction in water usage for cities and towns in California).

44 *See* Timothy Bralower & David Bice, *El Niño-Southern Oscillation*, PENN STATE U., https://www.e-education.psu.edu/earth103/node/687 [https://perma.cc/PZ7D-44Y2] (examining California's hopes that El Niño-Southern Oscillation will ameliorate the drought effects).

45 *See* Veronique Dupont, *El Niño Brings Rain to California but Won't End Drought*, PHYS.ORG (Oct. 19, 2015), http://phys.org/news/2015-10-el-Niño-california-wont-drought.html [https://perma.cc/6JXK-YBXA] (explaining that heavy rains in 2015 will not end the drought).

46 *See id*. (restating that heavy rains in California will not make up for the drought).

47 *See* Michon Scott & Rebecca Lindsey, *Early Years of California's Drought May Be Linked to Lingering Effect of La Niña*, NOAA CLIMATE.GOV (Apr. 20, 2015), https://www.climate.gov/news-features/featured-images/early-years-california%E2%80%99s-drought-may-be-linked-lingering-effect-la [https://perma.cc/4ASA-DS5A] ("[T]he cool phase of a natural climate pattern in the tropical Pacific—leads to somewhat dry winters in California. But a new analysis of historical data . . . suggests that dryness often deepens into drought the following year, even if the tropical Pacific has technically shifted back to "neutral" conditions."); *see also* Dupont, *supra* note 45 (supporting the belief that heavy rains in 2015 would not end the drought).

and thus, there is no need to address long-term climate adaptation strategies through hard, painful choices, which is a dangerous illusion.[48]

III. TWO LEVELS OF DROUGHT ADAPTATION STRATEGIES

When El Niño did not return in 2014–2015, reservoir and snowpack levels dropped to historic lows, and the state was forced to become much more aggressive in responding to the drought.[49] States may choose among two levels of drought adaptation strategies.[50] Level I strategies involve painful, but short-term reactive measures to stretch scarce supplies to buffer the state's economy and its citizens from the worst effects of the drought.[51] Level II strategies involve proactive long-term choices about

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[48] *See* Jason Cowan, *New Melones Reservoir at 13 Percent Capacity, but Filling*, UNION DEMOCRAT (Jan. 8, 2016), http://www.uniondemocrat.com/News/Local-News/New-Melones-Reservoir-at-thirteen-percent-capacity-but-filling# [https://perma.cc/X7SL-ULDA] (explaining in January 2016 the New Melones Reservoir on the Stanislaus River was only thirteen percent full and unlikely to fill even with the El Niño rains). There is vast literature on risk perception and communication, which seeks to understand how people understand and react to short- and long-term risks. *See, e.g.*, Howard Kunreuther et al., *Integrated Risk and Uncertainty Assessment of Climate Change Response Policies*, 2014 IPCC REP. 154 (2014), https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter2.pdf [https://perma.cc/PZZ8-F5XP] (concluding lay people consistently underestimate the risks of climate change); *see also* Dan M. Kahan et al., *The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks*, 2 NATURE CLIMATE CHANGE 732 (Oct. 2012) (providing support for the notion that the public lacks apathy over climate change).

[49] *See* Priya Krishnakumar et al., *One Year after California's Worst Snowpack Ever, Levels Are Back to 87% of Normal*, L.A. TIMES (Mar. 30, 2016), http://graphics.latimes.com/california-snowpack-2016/ [https://perma.cc/5Q74-5T9G] (discussing California's low amount of water in reservoirs and snowpack). El Niño arrived in January 2016, took a vacation in February, and returned to give northern California a "miracle March." *See El Niño Roars Back to Life; March Miracle in the Making*, CBS S.F. BAY AREA (Mar. 1, 2016), http://sanfrancisco.cbslocal.com/2016/03/01/el-Niño-roars-back-to-life-march-miracle-in-the-making/ [https://perma.cc/PF85-J5NQ] (explaining precipitation patterns in California in early 2016). March rains allowed the major reservoirs, such as Shasta and Oroville, to fill. *See* Matt Stevens, *Reservoirs Are Getting a Big Boost from "Miracle March" – But the Drought Isn't over Yet*, L.A. TIMES (Mar. 18, 2016), http://www.latimes.com/local/california/la-me-california-drought-20160318-story.html [https://perma.cc/AG2V-Y866] (describing the effects of heavy rainfall in March 2016 in California). However, southern California did not share in the March rains. *See* Christopher C. Burt, *Not Quite a "Miracle March" for California*, WEATHER UNDERGROUND (Mar. 31, 2016), https://www.wunderground.com/blog/weatherhistorian/not-quite-a-miracle-march-for-california [https://perma.cc/HSD2-KAUL] (explaining California received a large amount of precipitation in early 2016).

[50] *See Approaches to Climate Change Adaptation*, ENV.GO.JP 3–4 (Nov. 2010), https://www.env.go.jp/en/earth/cc/adapt_guide/pdf/approaches_to_adaptation_en.pdf [https://perma.cc/XNC7-ZASB] [hereinafter *Approaches*] (describing long-term and short-term adaptation strategies).

[51] *See id.* at i (explaining short-term adaptation strategies designed to encourage immediate responses to the effects of climate change).

how people can live and thrive in intensively cultivated and developed water-stressed landscapes.[52]

There are at least five basic Levels I strategies:

1. The imposition of mandatory urban and agricultural water conservation targets.[53]
2. The administration of quantified and unquantified water rights.[54]
3. The reform of water law to create clearer entitlements, and thus to encourage water markets.[55]
4. The reliance on market discipline to adjust crop production and water use.[56]
5. The creativity or effectiveness of individual responses to mandated conservation or market pressure.[57]

The Level II strategies are deeper. They include the development of new storage facilities, the development of alternative neglected or rejected supplies, the switch to crops less vulnerable to GCC, the concentration of irrigation on high value crops, and the design of new rural and urban landscapes based on the minimization of the adverse impacts on interruptible water supplies.[58] Level II strategies ultimately ask what

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52 *See id.* (discussing the characteristics of different adaptation strategies).

53 *See Water Conservation Act of 2009*, Cal. S.B. X7-7 (2009), http://www.water.ca.gov/wateruseefficiency/sb7/ [https://perma.cc/3Z8C-ENBB] (stating California's urban water reduction goals to reduce water use by twenty percent by 2020 and requiring agricultural water management plans).

54 *See The Water Rights Process*, ST. WATER RES. CONTROL BD. (2016), http://www.waterboards.ca.gov/waterrights/board_info/water_rights_process.shtml [https://perma.cc/5U7L-XM5V] (stating that water rights are property rights, but those with rights do not own the water itself and that appropriative rights are quantified by what is likely to be needed).

55 *See* The Editorial Board, *It's Time to Reform California's Inherited Water Rights: Editorial*, L.A. DAILY NEWS (May 8, 2015), http://www.dailynews.com/opinion/20150508/its-time-to-reform-californias-inherited-water-rights-editorial/1 [https://perma.cc/VYS5-YDL6] (admitting it is time for a reform of California's agricultural prior-appropriation water rights).

56 *See EDF Recommends Policy Reforms for California Water Market*, ENVTL. DEF. FUND (May 3, 2016), https://www.edf.org/media/edf-recommends-policy-reforms-california-water-market [https://perma.cc/DAR8-RF5T] (promoting a reform of California's water market, which will lead to improvement in ecosystems in poor communities).

57 *See* Adam Nagourney, *California Imposes First Mandatory Water Restrictions to Deal with Drought*, N.Y. TIMES (Apr. 1, 2015), http://www.nytimes.com/2015/04/02/us/california-imposes-first-ever-water-restrictions-to-deal-with-drought.html?_r=1 [https://perma.cc/UQE6-NBN9] (revealing owners of large farms are getting water from sources other than the local water agencies, but they still must provide detailed reports about their water use).

58 This Article focuses on the first four strategies, but individual adaptation is very important. *See Approaches, supra* note 50, at i (discussing different types of long-term adaptation strategies).

GCC-altered landscapes will look like and how the state's growing population can sustain itself in them.[59]

A. Level One Strategies

1. Water Conservation

Water use can initially be divided between consumptive and non-consumptive uses.[60] About fifty percent of California's annual water supply is devoted to non-consumptive, or *in situ environmental*, uses that are primarily utilized to support designated wild and scenic rivers in far northern California.[61] Hydropower production is also a non-consumptive use.[62] It is less controversial than instream flows, which often flow to the sea, because after power is generated, the water is available for downstream consumptive rights.[63] The next forty percent of the annual supply is consumed by irrigated agriculture; urban and industrial users account for the remaining ten percent.[64] If consumptive use, rather than total water supply, is the measure, agriculture accounts for about eighty percent of the state's consumptive use.[65] Nonetheless, in 2014 and 2015,

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[59] *See Climate Change Research Plan for California*, CAL. EPA 8, 30 (Feb. 2015), http://climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf [https://perma.cc/JNH9-X5A3] (discussing plans for climate change at the landscape-level and how sustainable communities can be created).

[60] For agricultural use, consumptive use "is the amount of water transpired and retained within a plant or animal during the growing season," in other words, water not returned to a stream or aquifer. THOMAS V. CECH, PRINCIPLES OF WATER RESOURCES: HISTORY, DEVELOPMENT, MANAGEMENT, AND POLICY 37 (2003).

[61] *See* Jeffrey Mount & Ellen Hanak, *Water Use in California*, PUB. POL'Y INST. OF CAL. (2016), http://www.ppic.org/main/publication_show.asp?i=1108 [https://perma.cc/EAR8-RJM9] (listing environmental water use allocation and the four different categories of environmental water use).

[62] *See Water Rights*, ST. WATER RES. CONTROL BD. (2016), http://www.waterboards.ca.gov/waterrights/board_info/faqs.shtml [https://perma.cc/95FB-BLJC] (identifying hydroelectric projects as a non-consumptive water use).

[63] *See id*. (noting that water is diverted for non-consumptive purposes before it is available for downstream use).

[64] *See* Mount & Hanak, *supra* note 61 (explaining the distribution of water use in California).

[65] *See* Heather Cooley et al., *Agricultural Water Conservation and Efficiency Potential in California*, NAT'L RES. DEF. COUNCIL (June 2016), https://www.nrdc.org/sites/default/files/ca-water-supply-solutions-ag-efficiency-IB.pdf [https://perma.cc/5T3V-6N3L] (explaining the impact of agricultural water use in California). This figure is often cited by environmentalists and urban water interests to argue that irrigated agriculture should either use water more efficiently or serve as the "reservoir" for future urban water supplies acquired through the market. *Id*.

the state set ambitious and hard targets for urban, but not agricultural, water users.[66]

There are two reasons for targeting cities rather than irrigated agriculture. First, agriculture is a major industry with considerable political clout, which is almost totally dependent on irrigation, although its value to California's total economy is actually quite small:

> Approximately nine million acres of farmland in California are irrigated, representing roughly 80% of all water used for businesses and homes. Higher revenue perennial crops—nuts, grapes, and other fruit—have increased as a share of irrigated crop acreage (from 27% in 1998 to 32% in 2010 statewide, and from 33% to 40% in the southern Central Valley). This shift, plus rising crop yields, has increased the value of agricultural water used. Farm production generated 60% more gross state product in 2014 than in 1980, even though farm water use was about 15% lower. But even as the agricultural economy is growing, the rest of the economy is growing faster. Today, farm production and food processing generate about 2% of California's gross state product, down from about 5% in the early 1960s.[67]

The second reason is that urban use is easier to curtail because the water service provider customers have only contractual or service rights rather than property rights.[68] In contrast, agricultural users have vested appropriative and riparian rights which, in theory, can only be curtailed through judicial or administrative proceedings.[69] To further complicate

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[66] *See* Adam Nagourney, *California Imposes First Mandatory Water Restrictions to Deal with Drought*, N.Y. TIMES (Apr. 14, 2015), http://www.nytimes.com/2015/04/02/us/california-imposes-first-ever-water-restrictions-to-deal-with-drought.html?_r=0 [https://perma.cc/UQE6-NBN9] (reporting on California's twenty percent reduction of water usage in 2014 and the twenty-five percent reduction in 2015).

[67] *See* Mount & Hanak, *supra* note 61 (explaining the distribution of water use in California). Agriculture accounts for 3.6% of the state's employment, 2.9% of labor income, and 2.5% of value added to the state's economy. *See* Mechel Paggi, *California Agriculture's Role in the Economy and Water Use and Characteristics*, CAL. ST. U. 5 (Nov. 2011), https://www.fresnostate.edu/jcast/cab/documents/pdf/Appendix-1-Economics-12-7-2.pdf [https://perma.cc/537Y-PKRV] (explaining the economic effects of agricultural production in California).

[68] *See* CAL. WATER CODE § 10910(d)(1) (2016) (identifying water supply entitlements and service contracts).

[69] *See California Water Rights Primer*, CAL. WATER IMPACT NETWORK, https://c-win.org/water-rights-primer/ [https://perma.cc/FA9A-QFU3] (comparing riparian and appropriative rights in California).

matters, many agricultural users have contractual rights that reflect the surrender of underlying property rights, but others only have contract rights to water obtained from federal or state projects.[70] This latter category applies primarily to the west side of the San Joaquin Valley; these contract rights can be curtailed when the water to supply the contract amount is not available.[71]

In early 2014, Governor Edmund G. (Jerry) Brown proclaimed a continued state of emergency in California, and in April 2015, he issued an Executive Order with, *inter alia*, mandatory urban conservation duties.[72] The Order set a statewide urban water use target that decreased the amount used in 2013 by twenty-five percent, to be achieved by February 2016.[73] Higher capacity use areas were to bear a proportionately

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[70] *See* Steven J. Herzog, *Guidelines for the Appraisal of Water Rights in California*, U.S. FISH & WILDLIFE SERV. (Sept. 2006), https://www.fws.gov/Cno/fisheries/docs/TitleContentsand ExecutiveSummary.pdf [https://perma.cc/TM6F-X4A2] (defining the contractual entitlements to water).

[71] *See DWR Increases 2015 Allocation to Water Contractors*, CAL. DEP'T OF WATER RES. (Jan. 15, 2015), http://www.water.ca.gov/news/newsreleases/2015/011515increases.pdf [https://perma.cc/FJ3R-44ZK] (explaining how winter storm runoff led to an increase in water supply). In 2015, the California Department of Water Resources announced that water deliveries from the State Water Project would be increased from ten percent to fifteen percent for the 2015 water year. *Id*. *See also Reclamation Announces Initial Water Supply Allocation for Central Valley Project*, USBR (Feb. 27, 2015), http://www.usbr.gov/newsroom/newsrelease/ detail.cfm?RecordID=48986 [https://perma.cc/9NBU-G96F] (discussing the unlikely scenario associated with agricultural water contractors not receiving water). Federal contractor holders were not so lucky. *Id.* The main Bureau of Reclamation reservoir for the Central Valley is Lake Shasta behind the Shasta Dam, which is north of Redding. *Id*. The dam stores both water to supply senior water rights as well as contractees. *Id.* In February 2015, the Bureau announced that there would be zero contract deliveries from the Central Valley Project. *Id*. *See also* Westlands Water Dist. v. United States, 337 F.3d 1092, 1097 (9th Cir. 2003) (discussing water contracts in California). There are two types of contracts on the west side of the San Joaquin Valley. Some districts have exchanged contract rights, which reflects the fact that the districts sold their pre-1914 riparian rights to the federal government to build the Central Valley project in return for firming up these rights through carry-over storage. *Id*. Newer districts, such as Westlands Water District, have only contract rights, which means that they get less than the exchange contractors in times of shortage. *Id*. *See also* Jeremy K. Lusk, *The Struggle for Water: How One Irrigation District Seeks Water Supplies*, 13 SAN JOAQUIN AGRIC. L. REV. 67, 68 (2003) (describing the controversial nature of water rights in the Westlands, which will not likely subside). The history and on-going struggle of the Westland Water District to sustain itself in the face of its uncertain water entitlements merits a book in and of itself. *Id*.

[72] *See* Cal. Exec. Order B-26-14 (2014) (proclaiming a state of emergency due to the drought); Cal. Exec. Order B-28-14 (2014) (stating the California drought required a declaration of a state of emergency); Cal. Exec. Order B-29-15 (2015) (declaring a continued state of emergency and utilizing CAL. GOV. CODE §§ 8567, 8571 to create water restrictions). The conservation will be rolled back in light of the 2015–2016 El Niño winter rains. Cal. Exec. Order B-29-15 (2014).

[73] *See id*. ¶ 2 (2015) (reducing the statewide use of potable water in urban areas by twenty-five percent).

greater burden of compliance.[74] Softer obligations were also imposed.[75] Other parts of the Order built on the state's on-going efforts to use reclaimed waste water for urban irrigation.[76] For example, the Order directed the Department of Water Resources to implement a program to replace fifty million square feet of green "Midwestern" lawns with more drought tolerant landscaping.[77] Golf courses and other large green landscape areas were subjected to future restrictions on the use of potable water.[78]

To implement the Order, the responsibility of water conservation was shifted directly to urban users.[79] Effective implementation ultimately requires two fundamental value or norm shifts in addition to traditional sanctions such as fines.[80] Both shifts are occurring, but at uneven rates.[81] The first shift is the internalization of the norm that less water use from less toilet flushing to xeriscaping is necessary to sustain the state.[82] The emergence of this goal might seem unrealistic because water conservation raises the classic collective action problem: an individual is likely to forego compliance because the individual benefit to society is small and the belief that others will conserve enough to meet the target.[83] Nonetheless, overall, the state met its goals at the expense of the loss of

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74 *See id*. (stating areas with higher usage will bear most of the burden of the water restrictions as compared to those with low water use).

75 *See id*. ¶ 6–7 (communicating the prohibition of the use of potable water for irrigating ornamental turf and newly constructed homes).

76 *See id*. (targeting water reduction policies in urban areas, such as public street medians).

77 *See id*. ¶ 3 (directing local agencies in California to replace lawns with drought tolerant greenery).

78 *See* Cal. Exec. Order B-29-15 ¶ 5–6 (requiring water efficiency measures for industrial, commercial, and institutional properties). The Water Resources Control Board was also directed to prohibit the use of potable water for ornamental turf on public street medians. *Id*.

79 *See id*. ¶ 2 (citing an Executive Order imposing a higher water conservation standard of twenty-five percent on urban users).

80 *See generally* RICHARD MCADAMS, THE EXPRESSIVE POWER OF LAW: THEORIES AND LIMITS (2015).

81 *See supra* notes 72–78 and accompanying text (referring to multiple Executive Orders in California limiting water use).

82 *See, e.g.*, Michael P. Vandenberg & Ann C. Steinemann, *The Carbon-Neutral Individual*, 82 N.Y.U. L. REV. 1673, 1707 (2007) (hypothesizing that shifts in beliefs and norms can change behavior). In recent years, there have been ambitious efforts to shift responsibility for achieving environmental and social goals from state coercion to individual internalization of compliance norms, or at least to provide incentives, such getting social esteem or avoiding shame. *Id*.

83 *See* MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS 64 (1971) (explaining that social pressure may be ineffective on a large group).

green urban landscapes, although some communities with a plus twenty-five percent goal did not.[84]

This second value transformation is the recognition that excessive use is not just necessary, but shameful. Having a green lawn or taking a long, hot shower is not usually put in the same category as drunk driving or not picking up after your dog. But again, this new shame-based norm is slowly emerging.[85] There are precedents for peer-enforced water use practices.[86] Small water use communities such as acequias, like common ditches in New Mexico, have developed norms of shared, responsible use enforced by peer sanctions.[87] In the digital age, a virtual community can quickly distribute shaming information.[88] Wealthy communities, institutional users, such as the San Francisco 49ers, and high profile individuals who have not conserved have begun to feel the sting of community pressure as a new norm of shared, restrained use emerges.[89] These large users have been increasingly "outed" as water hogs.[90]

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[84] *See* Newsmax Wires, *California Drought: 25 Water-Reduction Goal Nearly Met*, NEWSMAX (Apr. 5 2016), http://www.newsmax.com/TheWire/california-drought-25-percent/2016/04/05/id/722401/ [https://perma.cc/JS92-QRAL] (explaining the effects of California's 2015 executive order to reduce water use).

[85] *See* Karen Sternheimer, *Social Interaction and Drought Shaming*, EVERYDAY SOC. BLOG (Oct. 2, 2014), http://www.everydaysociologyblog.com/2014/10/social-interaction-and-drought-shaming.html [https://perma.cc/JC8Q-LEHK] (cautioning that water shaming is becoming more prevalent and is not necessarily effective).

[86] *See* Gregory A. Hicks & Devon G. Peña, *Community Acequias in Colorado's Rio Culebra Watershed: A Customary Commons in the Domain of Prior Appropriation*, 74 U. COLO. L. REV. 387, 388 (2003) (discussing the community-based water system of Hispanic settlers after the Mexican War).

[87] *See* MICHAEL C. MEYER, WATER IN THE HISPANIC SOUTHWEST: A SOCIAL AND LEGAL HISTORY 1550–1850, 20–21 (1984) (detailing the use of acequias, also known as irrigation ditches, in the southwest United States); *see also* STANLEY CRAWFORD, MAYORDOMO: CHRONICLE OF AN ACEQUIA IN NORTHERN NEW MEXICO xi–xii (1987) (examining the historical context of acequias in New Mexico).

[88] *See* Ashley Collman, *The Grass IS Greener in Hollywood: Aerial Photos Expose How Stars Like Kim K, J.Lo and Streisand Are Wasting Water to Keep Their Gardens Lush Despite State's Worst Drought in History,* DAILY MAIL (May 10, 2015), http://www.dailymail.co.uk/news/article-3075906/What-drought-Aerial-photos-expose-Kim-Kardashian-Jennifer-Lopez-Barbra-Streisand-greedy-celebrities-wasting-water-lush-lawns-green-midst-California-s-worst-drought-history.html [https://perma.cc/6NCD-S9V5] (exposing evidence of green celebrity lawns amid the California drought).

[89] *See id*. (observing that celebrities appeared to be content to pay the fine for overusing water); *see also Stadium Sets New Standard for the Use of Recycled Water,* LEVI'S STADIUM (June 10, 2014), http://www.levisstadium.com/2014/06/stadium-sets-new-standard-use-recycled-water [https://perma.cc/AE9H-FKSG] (demonstrating to the public that the 49ers' franchise has made strides to limit water consumption).

[90] *See* Pete Suratos & NBC Bay Area Staff, *EBMUD Should be 'Ashamed' after Water Guzzler Goof: Report,* NBC BAY AREA (Jan. 27, 2016), http://www.nbcbayarea.com/news/local/EBMUD-Should-Be-Ashamed-After-Water-Guzzler-Goof-Report-366730201.html [https://perma.cc/GMX2-5FVH] (noting that the East Bay Municipal Utility District

The mandatory reduction targets were lifted for eight months in May 2016.[91] Conservation targets are now set by local water suppliers based on local water supply projections.[92] These projections must assume three consecutive abnormally dry years.[93]

2. Water Rights Administration

As mentioned previously, California's law of water rights is unique, complex, dysfunctional, and biased in favor against excessive use and curtailment risk avoidance.[94] "The California water rights system does not explicitly or transparently allow for risk assessment, and does not manage risk."[95] Unlike other Western states, California does not have tight administration of existing water rights, in large part because it lacks the necessary water use information to do so, although the state has slowly begun to remedy this problem.[96]

The root of California's water management problem is the welter of inchoate rights. There are three major categories of surface rights, at least four categories of groundwater rights, a variety of state and federal contract entitlements, and federal Indian and non-Indian reserved rights, most of which are unquantified.[97] Thus, water rights do not, as they do in most Western states, function to allocate water or distribute the pain of

("EBMUD") has admitted that some numbers in a list of non-compliant users were "inflated").

91 *See* Adam Nagourney & Ian Lovett, *In Sharp Reversal, California Suspends Water Restrictions*, N.Y. TIMES (May 18, 2016), http://www.nytimes.com/2016/05/19/us/california-suspends-water-restrictions.html?_r=1 [https://perma.cc/Z5JY-Q286] (stating that the twenty-five percent reduction target for water usage was suspended).

92 *See id*. (noting that local authorities now have control over water use).

93 *See id*. (addressing the new three-year standard).

94 *See supra* Part II.A–B (discussing the history of California's water law and the necessity of taking natural disasters into account).

95 *See* Michael Hanemann et al., *Climate Vulnerability and Adaptation Study for California: Legal Analysis of Barriers to Adaptation for California's Water Sector*, CAL. NAT. RES. AGENCY 1 (July 2012) (introducing California's Energy Commission Publication 2012).

96 *See* HENRY HOLSINGER, NECESSITY FOR COMPREHENSIVE ADJUDICATION OF WATER RIGHTS ON THE SACRAMENTO AND SAN JOAQUIN RIVERS IN AID OF THE CENTRAL VALLEY PROJECT 1 (Dec. 10, 1942) (discussing how in 1942, the chief attorney for the California Division of Water Resources wrote a long memorandum arguing the failure to adjudicate water rights in the Central Valley would impede the management of the Central Valley Project); *see also Bay Delta Strategic Plan Before the State Water Resources Control Board* (July 16, 2008), (statement of Bill Jennings, California Sport Fishermen's Alliance), http://www.calsport.org/7-17-08c.htm [https://perma.cc/V2CL-VEG8] (testifying to the position of Henry Hollsinger regarding the necessity of water rights on the Sacramento and San Joaquin rivers).

97 *See* Hanemann et al., *supra* note 95, at 7 (discussing the different categories of California's water law).

shortage.[98] Instead, there are licenses to divert without limitation until the state or another user contests the diversion.[99] This needlessly complex system makes it difficult to adjust to droughts and to a world of more constrained supplies due to GCC.

Geography and history have contributed to California's unique water law.[100] States along the 100th Meridian and the Pacific Coast initially adopted the common law of riparian rights.[101] As settlement moved into the arid portions of the states, states switched to prior appropriation.[102] All exercised riparian rights were converted to appropriative rights and all unexercised, inchoate riparian rights were eventually abolished.[103] Only California, along with Nebraska and Oklahoma, remain dual system states with substantial, valid, exercised, and inchoate riparian rights.[104]

California was the first state to adopt prior appropriation, but it did so on common law grounds, which laid the foundation for the later recognition of riparian rights.[105] The courts initially applied prior appropriation to disputes among gold miners either because it was customary of the camps or the common law awards property rights to the first possessor, even if better title exists in a third party not before the

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98 *See* Brian Gray et al., *Allocating California's Water: Directions for Reform*, PUB. POL'Y INST. OF CAL. 5 (Nov. 2015), http://www.ppic.org/content/pubs/report/R_1115BGR.pdf [https://perma.cc/9LSW-24F6] ("[T]he water allocation system remains hampered by inconsistencies, unclear regulatory authorities, and a lack of transparency and information . . . .").

99 *See Water Rights: Issues and Perspectives*, LEGIS. ANALYST'S OFF. 2 (Mar. 10, 2009), http://www.lao.ca.gov/handouts/resources/2009/water_rights_issues_perspectives_031009.pdf [https://perma.cc/HJY7-FSGA] (analyzing diversion practices for energy consumption). The analysis goes on to state, "[w]ater rights exceed actual total water volume availability on almost all river systems in the state. This in part reflects the fact that water may be reused as it runs off farms or may be returned to the river after use for a 'non-consumptive' diversion purpose such as energy production." *Id*.

100 *See* HANAK ET AL., *supra* note 22, at 71 (highlighting the importance of California's history and geography in shaping the current water law).

101 *See* Taiawagi Helton, *Indian Reserved Water Rights in the Dual-System State of Oklahoma*, 33 TULSA L.J. 979, 982 (1998) (discussing the adoption of riparian water law in states along the 100th meridian).

102 *See id*. at 983 (explaining that mining camps were the driving force behind the shift to the prior appropriation doctrine).

103 *See* A. DAN TARLOCK ET AL., WATER RESOURCE MANAGEMENT: A CASEBOOK IN LAW AND PUBLIC POLICY 477–81 (7th ed. 2014) (elaborating on the history of riparian rights).

104 *See* Helton, *supra* note 10, at 982 (stating California is joined only by Nebraska and Oklahoma in using a dual system).

105 *See* SAMUEL C. WIEL, WATER RIGHTS IN THE UNITED STATES 246–47 (3d ed. 1911) (discussing the early use of prior appropriation to unoccupied lands).

court.[106] And there was a third party with superior title.[107] The federal government acquired riparian rights, as a land owner, when it succeeded to the rights of Mexico.[108] Thus, this rationale ultimately precluded California courts from declaring that riparian rights never existed in the state.[109] Unlike the hard core arid states, which rejected riparian rights as unsuited to the arid west and claimed that the federal government had no water rights, California always recognized that the federal government was the source of all land and water titles.[110] Therefore, all federal patents conveyed full riparian rights, including the right to initiate a use at any time.[111] California courts recognized one limited exception: riparian rights are superior to all post-patent appropriations except pre-patent appropriations.[112]

To add to the complexity, California recognizes both non-statutory, or customary, and statutory appropriative rights.[113] California did not adopt a statewide permit system until 1914, long after large acreages were irrigated with riparian or pre-1914 appropriative rights.[114] To encourage users to apply for a statutory right, courts and the state constitution have limited riparian rights in two important ways. First, riparian rights can

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106 *See* Irwin v. Phillips, 5 Cal. 140, 141 (1855) (recognizing the doctrine of appropriative rights to water as being the same as appropriative rights to land).

107 *See* Frank J. Trelease, *Government Ownership and Trusteeship of Water*, 45 CAL. L. REV. 638, 649 (1957) (discussing state versus federal ownership rights).

108 *See id.* (comparing the acquisition of Mexican territory to the United States' public domain with the same property right as an individual to own a farm).

109 *See* WIEL, *supra* note 105, at 745–46 (explaining how the common law has been minimally modified).

110 *See* Christine A. Klein, *Treaties of Conquest: Property Rights, Indian Treaties, and the Treaty of Guadalupe Hidalgo*, 26 N.M. L. REV. 201, 229 (1996) (noting that the Treaty of Guadalupe Hildago ceded much of the West to the United States); *see also* Cal. Or. Power Co. v. Beaver Portland Cement Co., 295 U.S. 142, 153–54 (1935) (showing how the western states mounted a decade long, successful legal battle to convince the Supreme Court that Congress enacted a series of statutes that allowed states to choose between appropriation and the common law); Coffin v. Left Hand Ditch Co., 6 Colo. 443, 449 (1882) (finding that Colorado adopted the theory that prior appropriation was always the law of the state due to the "imperative necessity for artificial irrigation of the soil").

111 *See* Trelease, *supra* note 107, at 650 (describing the relationship between federal patents and prior appropriation).

112 *See* B. Abbott Goldberg, *Interposition–Wild West Water Style*, 17 STAN. L. REV. 1, 11 (1964) (stating that California recognizes that a prior appropriator on the public domain may obtain a right superior to a subsequent federal patentee, but an appropriator on private land is subordinate to an upstream patentee of riparian land); *but see In re* Waters of Long Valley Creek Stream Sys., 599 P.2d 656, 668 (Cal. 1979) (finding the limited exception that unused riparian rights can be awarded a junior priority in an adjudication, and thus, are subordinate to all existing consumptive use rights).

113 *See* HANAK ET AL., *supra* note 22, at 23 (distinguishing between California's appropriative and riparian water rights).

114 *See id*. at 38 (discussing California's implementation of the permit system in 1914).

only be used on riparian land and within a stream's watershed, which the California Supreme Court has defined narrowly.[115] The result is that in places such as the California Delta, there are large amounts of non-riparian land.[116]

The second limitation is a constitutional amendment that subjects riparian rights, and to a lesser extent appropriative rights, to potentially stringent reasonable use standards.[117] The California Supreme Court initially adopted the common law theory that each riparian was entitled to the unaltered natural flow of a stream, but after an intense campaign led by the electric power industry, the state Constitution was amended to impose a reasonable use limitation on all riparian rights.[118] The uncertain scope of these rights and the courts' increasingly aggressive implementation of the Amendment pushed users to acquire an appropriative right with a fixed quantity.[119]

With that being said, large amounts of water in California remain un-administered in the state, and there are substantial legal questions whether riparian and pre-1914 appropriative rights can be administered by the state.[120] The Board has express authority to curtail post-1914 appropriative rights, but no direct authority to curtail pre-1914 appropriative or common law riparian rights.[121] The Board relies on the following broad section of the Water Code: "[t]he department and board shall take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state."[122]

There are two precedents on which the Board can rely, but neither permits the adjudication and administration of pre-1914 appropriative

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115 *See* Anaheim Union Water Co. v. Fuller, 88 P. 978, 981 (Cal. 1907) (holding riparian rights attach to the tracts that have been riparian through the post-patent chain of title, and thus, the conveyance of land that no longer abuts a stream is non-riparian).

116 *See, e.g.*, Rancho Santa Margarita v. Vail, 81 P.2d 533, 543 (Cal. 1938) (mediating a dispute over whether certain property in the Murieta area is nonriparian).

117 *See* CAL. CONST. art. X, § 2 (instituting the standard of reasonable use as a restriction on riparian rights).

118 *See id*. (creating a new limitation on riparian rights in California); Herminghaus v. S. Cal. Edison Co., 252 P. 607, 627 (Cal. 1926) (upholding the common law doctrine before being superseded by the constitutional amendment).

119 *See, e.g.*, Peabody v. City of Vallejo, 40 P.2d 486, 498–99 (Cal. 1935) (holding the court has the ability to regulate the parties' disputes in accordance with the constitutional amendment).

120 *See* Hanemann et al., *supra* note 95, at 9 (observing the legal gaps between the courts and the State Water Board).

121 *See* CAL. WATER CODE § 878 (2016) (granting authority to the Board).

122 § 275.

rights and common law riparian rights.[123] The first precedent resulted from a challenge to the Board's regulations to limit the use of water for vineyard frost irrigation because of the impact of the diversions on endangered fish in the Russian River.[124] A trial court invalidated the rule as impairing the vineyard owner's common law riparian rights, but the appellate court upheld the Board's power to apply the reasonable use constitutional amendment to common law riparian rights.[125] *Light v. State Water Resources Control Board* reasoned: "[s]ince enactment of Article X, Section 2, 'there can no longer be any property right in the unreasonable use of water'"; riparian users' vested water rights extend only to reasonable beneficial water use, which is determined at the time of use.[126]

The court also suggested that pre-1914 appropriative rights could also be regulated under the state's public trust doctrine:

> [N]o party can acquire a vested right to appropriate water in a manner harmful to public trust interests and the state has "an affirmative duty" to take the public trust into account in regulating water use by protecting public trust uses whenever feasible. Although the *Audubon Society* court considered the public trust doctrine only in relation to permitted appropriative water rights, subsequent decisions have assumed the doctrine applies as well in the context of riparian and pre-1914 appropriator rights.[127]

However, in dicta, the court limited the Board's power to curtail pre-1914 appropriative rights to prevent the unreasonable use of water.[128] The

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123 *See The Water Rights Process*, *supra* note 54 (explaining diversions of pre-1914 appropriative and common law rights).

124 *See* 173 Cal. Rptr. 3d 200, 206 (Cal. Ct. App. 2014) (balancing the potential harm to the Salmonid fish population against the commonly used practice of diverting water to prevent grapes from frost damage).

125 *See id*. at 222–23 (finding that the Board had the ability to make the factual determination of what was reasonable).

126 *Id*. at 217.

127 *Id*. at 218–19 (internal citation omitted) (emphasis in original).

128 *See id*. at 218 (responding to the plaintiff's contention that the Board violated the rule of priority). Responding to this allegation, the court stated:

> In analyzing this contention, we start with the premise that the supply of water in California is variable and at times insufficient to supply all possible beneficial uses. As the circumstances of this appeal demonstrate, this may be true on a temporary and localized basis, as well as on a more global one. When the supply of water in a particular stream system is insufficient to satisfy all beneficial uses, water rights users must curtail their use. As discussed above, the rule of priority dictates that riparian users are satisfied first, but when the supply runs

court first reasoned that "when the rule of priority clashes with the rule against unreasonable use of water, the latter must prevail" because "no one can have a protectable interest in the unreasonable use of water."[129] However, the court made it clear that priorities must be observed in assigning responsibility to comply with the Board's regulation.[130]

The second case held that the Board may issue cease and desist orders to prohibit illegal diversions of pre-1914 appropriative and common law riparian rights.[131] The court based its decision on section 1831 of the Water Code which provides in part:

> (a) When the board determines that any person is violating, or threatening to violate, any requirement described in subdivision (d), the board may issue an order to that person to cease and desist from that violation.
> . . .
> (d) The board may issue a cease and desist order in response to a violation or threatened violation of any of the following:
> (1) The prohibition set forth in Section 1052 against the unauthorized diversion or use of water subject to this division.[132]

The court did not explain how the Board determined that the diversions were illegal and did not elaborate on the Board's discretion to make these determinations.[133]

The extent of the Board's power to administer pre-1914 appropriative rights is illustrated by an ill-fated attempt in 2014 and 2015.[134] The State Water Resources Control Board briefly imposed diversion limits on pre-1914 appropriative rights and common law riparians, but the orders were

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> sufficiently short, even riparian users must curtail their beneficial use proportionately.

Id.

129 *Light*, 173 Cal. Rptr. 3d at 218.

130 *See id.* ("[E]very effort . . . must be made to respect and enforce the rule of priority.").

131 *See* Young v. State Water Res. Control Bd., 161 Cal. Rptr. 3d 829, 833 (Cal. Ct. App. 2013) (analyzing plaintiff's argument that the Board had no statutory jurisdiction over pre-1914 water rights).

132 CAL. WATER CODE § 1831 (2016).

133 *See Young*, 161 Cal. Rptr. 3d at 835 (recognizing both issues, but only analyzing the jurisdiction granted by the Water Code).

134 *See* West Side Irrigation Dist. v. Cal. State Water Res. Control Bd., No. 34-2015-80002121, at *5 (Sup. Ct., County of Sacramento, July 10, 2015), http://www.waterboards.ca.gov/press_room/press_releases/2015/west_side_irr%20_v_cswrcb.pdf [https://perma.cc/H4LK-VC48] (granting an ex parte restraining order).

immediately successfully challenged on due process grounds at the trial court level.[135]

3. Water Law Reform: Curtailing Unlimited Groundwater Pumping

California spent most of the twentieth century trying to take the risk out of water rights, but the state is now trying to reform its water law to introduce risk back into water rights, as is the case in all other western states.[136] A major study of California's water resources and water law recommended four fundamental reforms: (1) equal treatment for groundwater; (2) more effective regulation of pre-1914 appropriative rights as well as riparian rights; (3) better water accounting; and (4) a stronger law of water transfers.[137] The state addressed the first recommendation in 2014, the third in both 2009 and 2015, but the second and fourth recommendations await legislative action.[138] California's unique and comprehensive, but convoluted, regulation of groundwater use is the most significant reform since appropriation permits were required for all new appropriations in 1914.

More radical proposals exist to replace prior appropriation with the Australian system of non-priority volumetric entitlements.[139] An Australian water scholar has argued that all appropriative rights should be converted to shares of yearly or seasonably available water to provide clearer entitlements and to trigger more trading.[140] So far, California has not taken up the challenge to replace prior appropriation with Australia's volumetric allocations with pro rata sharing in times of drought.[141]

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135 *See id*. ("The Curtailment Letters, including the requirement that recipients sign a compliance certification confirming cessation of diversion, result in a taking of Petitioners' property rights without a pre-deprivation hearing, in violation of Petitioners' Due Process Rights.").

136 *See* HANAK ET AL., *supra* note 22, at 33–53 (discussing the history and current developments of California's water law).

137 *See id*. at 323–32 (explaining the proposed water reforms for California).

138 *See* CAL. WATER CODE § 10608.48 (2010) (setting restrictions on agricultural water suppliers and aiming to make more efficient water practices in California).

139 *See* Michael Young et al., *Unbundling Water Rights: A Blueprint for Development of Robust Water Allocation Systems in the Western United States,* DUKE NICHOLAS INST. FOR ENVTL. POL'Y SOLUTIONS 15 (Sept. 2015), https://nicholasinstitute.duke.edu/water/publications/unbundling-water-rights-blueprint-development-robust-water-allocation-systems-western [https://perma.cc/XSX4-4R3R] (describing the formula used in the model share system).

140 *See id.* (explaining to ease the transition, the initial allocation of shares should be based on priority).

141 *See id.* at 1 (providing an overview of the potential changes that could occur if the system were implemented in the western United States).

Groundwater has always been the state's rainy day fund.[142] Southern California had limited groundwater use through basin adjudications and settlements, but pumping in the Central Valley remained virtually unregulated.[143] Not surprisingly, pumpers in the Central Valley resisted for decades any statewide regulation and adjudication at the expense of a growing overdraft and land subsidence.[144] In 2013–14, drought changed the politics of groundwater regulation, but statewide regulation remained off the table.[145] The legislature's best political option was to build on the long tradition of local groundwater solutions.[146]

In recognition of this history, the 2014 Sustainable Groundwater Management Act divides the state into two areas, southern California and the rest of the state.[147] Southern California's existing administered settlements are left in place.[148] For the rest of the state, the legislation puts in place the most ambitious effort to test the theory that common property resources can be managed locally, rather than statewide.[149] The new law

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142 *See* San Diego Union-Tribune Editorial Board, *California May Have a Water Rainy Day Fund*, SAN DIEGO UNION TRIB. (July 1, 2016), http://www.sandiegouniontribune.com/opinion/editorials/sdut-california-water-windfall-2016jul01-story.html [https://perma.cc/XSX4-4R3R] (referring to a study showing that California may have as much as three times the underground water as previously estimated).

143 *See* WILLIAM BLOMQUIST, DIVIDING THE WATERS: GOVERNING GROUNDWATER IN SOUTHERN CALIFORNIA 14 (1992) (detailing the unregulated pumping process used in the Central Valley); *see also* Elinor Ostrom, Public Entrepreneurship: A Case Study in Ground Water Basin Management (1965) (unpublished Ph.D. dissertation, University of California), https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/3581/eostr001.pdf?sequence=1 [https://perma.cc/Z6QS-BXDF] (discussing the efforts among the groundwater agencies in southern California to cooperate to halt salt water intrusion from over-pumping).

144 *See* Barbara T. Andrews & Sally K. Fairfax, *Groundwater and Intergovernmental Relations in the Southern San Joaquin Valley of California: What Are All the Cooks Doing to the Broth?*, 55 U. COLO. L. REV. 145, 153–54 (1984) (noting that the Valley practiced a limited form of conjunctive use by categorizing groundwater use to the availability of surface water, especially federal and state water deliveries); *see also* HANAK ET AL., *supra* note 22, at 78 ("[c]hronic overdraft—essentially groundwater mining—could be as high as 2 millionacre-feet per year ("maf/year") on average statewide"). As much as 1.4 maf/year of overdraft occurs from agricultural uses in the Tulare Basin–the Kern, Tulare, and Kings Counties. *Id*. In the Central Coast, the Salinas Basin also suffers from chronic groundwater overdraft–about 19 thousandacre-feet per year ("taf/year")–largely from agricultural pumping. *Id*.

145 *See* KQED Science, *What to Know about California's New Groundwater Law*, ASSOCIATED PRESS (Sept. 17, 2014), https://ww2.kqed.org/science/2014/09/17/what-to-know-about-californias-new-groundwater-law/ [https://perma.cc/Y7QU-DW3G] (detailing the politics behind the local approach that was adopted in California).

146 *See* Baldwin v. Cty. of Tehama, 31 Cal. App. 4th 166, 179–80 (Cal. App. Ct. 1994) (holding that the local groundwater regulation was not preempted by any state legislation).

147 *See* CAL. WATER CODE § 10729(d)(2) (2016) (specifying the allocation of California's water districts).

148 *See id*. § 10720.8(a) (providing that the Act excludes the twenty-six adjudicated basins in Southern California and exempts two other basins with on-going adjudications).

149 *See* § 10726.8 (establishing local agencies with enforcement authority).

relies on local or regional Groundwater Sustainability Agencies that are charged with the adoption and implementation of sustainability plans.[150] Fifteen existing agencies are initially designated as Groundwater Sustainability Agencies.[151] Local governments in non-listed high priority basins must designate a governing agency.[152]

The Act adopts sustainable use as the overarching goal: "groundwater resources [must] be managed sustainably for long-term reliability and multiple economic, social, and environmental benefits for current and future beneficial uses."[153] The Department of Water Resources Bulletin identified a number of existing basins outside of Southern California and divided them into four categories: (1) very low priority; (2) low priority; (3) medium priority; and (4) high priority.[154] Critically over-drafted basins must implement a sustainable management plan by 2020.[155] In January 2016, the Department of Water Resources released its final list of twenty-one such basins.[156] All other high and medium priority basins have until 2022 to implement a plan.[157]

Designated sustainability agencies can determine whether the basin needs management after considering eleven factors that encompass a wide range of water management goals, including environmental protection and social equity.[158] Plans are mandatory for high and medium priority basins.[159] Key elements of the plan include the mandatory measurement of the amount of groundwater extracted and voluntary field

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150 *See* § 10723.6 (detailing the formation of groundwater stability agencies).

151 *See* § 10723(c)(1) (listing the fifteen existing agencies).

152 *See* § 10722.4(d) (establishing that agency formation must occur under a high-priority designation); *see also* § 10723.6 (explaining the formation of agencies); § 10723.2 (outlining the interests that are meant to be considered).

153 § 113.

154 § 10722.4. *See Sustainable Groundwater Management Program: Draft Strategic Plan*, CAL. DEP'T OF WATER RES. (Mar. 9, 2015), http://www.water.ca.gov/groundwater/sgm/pdfs/DWR_GSP_DraftStrategicPlanMarch2015.pdf [https://perma.cc/84YR-K87B] (discussing the division of existing basins into four distinct categories according to priority).

155 *See* § 10720.7(a)(1) (stating basins of high or medium priority must be updated by January 31, 2020).

156 *See Critically Overdrafted Basins (1/2016)*, CAL. DEP'T OF WATER RES. http://www.water.ca.gov/groundwater/sgm/pdfs/COD_BasinsTable.pdf [https://perma.cc/557R-BVL2] (listing the twenty-one overdrafted basins).

157 *See* § 10720.7(a)(2) (providing that by January 31, 2022, basins must be updated).

158 *See* § 10723.2 (listing the factors that may include all major ground and surface users, including environmental users, local land use planning agencies, the federal government, Native American tribes, and disadvantaged communities); *see also* § 10735.4 (addressing the procedures necessary in remedying a deficiency of a probationary basin).

159 *See* § 10726.2 (depicting the power a groundwater sustainability agency may exercise in various situations).

fallowing.[160] The plans must have four clusters of mandatory elements: (1) the physical setting and characteristics of the basin's aquifer; (2) measurable sustainability objectives; (3) a planning of the basin's implementation horizon; and (4) components such as monitoring of extractions, quality degradation and subsidence, overdraft mitigation strategies, recharge options, and a summary of available surface water for recharge.[161] Plans may include optional elements, such as the control of saline intrusion, replenishment measures, wellhead and recharge area protection, efficient water management practices, and containment abatement.[162]

The agencies are given extensive, new powers similar to those that have long been exercised in other states, but with greater planning mandates and more flexibility.[163] The powers include: (1) well spacing requirements; (2) the limitation of extraction, which establishes the allocations necessary for groundwater extraction; (3) temporary and permanent transfers of these allocations within the basin; and (4) allowances for year to year carryover of unused extraction allowances.[164] The question is whether local agencies can manage to actually comply with the stringent requirements of the legislation, as an objective evaluation of California's experiment is years away.[165] One major unanswered question, which the Act does not fully address, is the relationship between agency restrictions and inchoate water rights.[166] The Act only states that administrative allocations do not constitute a final determination of a landowner's rights under California's groundwater case law.[167]

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160 *See* § 107264(a)(2) (explaining the authority of groundwater sustainability agencies); *see also* § 10725.8 (expanding upon groundwater extraction and devices for measuring water).

161 *See* § 10727.2(a) (describing the mandatory elements required for a groundwater sustainability plan).

162 *See* §§ 10727.4(a), (e), (i) (discussing the optional elements of a groundwater sustainability plan).

163 *See* § 10725 (granting groundwater sustainability agencies the power to achieve sustainability goals through control and flexibility in planning).

164 *See* § 10726.4(a) (explaining the powers that the agencies possess).

165 *See id.* (outlining the duties that agencies must follow).

166 *See* § 10720.1 (demonstrating a lack of guidance regarding the legislation that addresses agency restrictions and water rights).

167 *See* § 10726.4(a)(2) (illustrating the Act provides allocations that are not final determinations of rights regarding extractions).

4. The Market and the Water-Food Nexus

California irrigators have the right to select the crops that they will grow.[168] However, world commodity markets increasingly make decisions about water and crop use.[169] The cases of California almond and cotton production illustrate both the benefits and risks of reliance on world markets.[170] In recent years, farmers were urged to shift from high water using crops, such as cotton, to almonds.[171] Almonds are a relatively efficient water use crop, but it still takes a gallon of water to produce a single almond.[172] During the 2012–2015 California drought, questions were raised about the wisdom of the expansion of almond acreage because tree crops cannot be fallowed; however, the expansion is economically rational.[173] World-wide demand for almond products, in part because of their health benefits, is growing.[174] California now produces eighty-two percent of the world's almonds and combined with walnuts and

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168 *See* Steven Wallander, *California's Irrigation Varies by Crop*, U.S. DEP'T OF AGRIC. ECON. RES. SERV. (July 6, 2015), http://www.ers.usda.gov/amber-waves/2015-july/california's-irrigation-varies-by-crop.asp#.V-irkTQjpll [https://perma.cc/MHW9-LLDR] (inferring California irrigators choose their crops).

169 *See* Woonghee Tim Huh & Upmanu Lall, *Optimal Crop Choice, Irrigation Allocation, and the Impact of Contract Farming*, 22 PRODUCTION & OPERATIONS MGMT. 1126, 1127 (2013), http://water.columbia.edu/files/2014/09/huh-contractirrigationallocation.pdf [https://perma.cc/WZ7N-QSQT] (detailing how world commodity markets influence crop selection).

170 *See* Eric Holthaus, *Stop Vilifying Almonds*, SLATE (Apr. 17, 2015), http://www.slate.com/articles/business/moneybox/2015/04/almonds_in_california_they_use_up_a_lot_of_water_but_they_deserve_a_place.html [https://perma.cc/XL86-QAD5] (demonstrating the reliance of cotton and almond production on the world market).

171 *See* Tom Philpott & Julia Lurie, *Here's the Real Problem with Almonds*, NEW REPUBLIC (Dec. 31, 2015), https://newrepublic.com/article/125450/heres-real-problem-almonds [https://perma.cc/R6G9-4XJQ] (establishing that farmers have shifted from growing cotton to growing almonds).

172 *See* Erin Brodwin & Samantha Lee, *Chart Shows How Some of Your Favorite Foods Could Be Making California's Drought Worse*, BUS. INSIDER (Apr. 8, 2015), http://www.businessinsider.com/amount-of-water-needed-to-grow-one-almond-orange-tomato-2015-4 [https://perma.cc/C462-9FUY] (illustrating how a single almond needs a gallon of water to grow).

173 *See* Holthaus, *supra* note 170 (addressing the doubt surrounding almond expansion because the tree crops cannot be fallowed, yet arguing that its expansion is justified).

174 *See California Almond Industry Facts*, CAL. ALMONDS: ALMOND BD. OF CAL. (Feb. 2015), http://www.almonds.com/pdfs/california-almond-industry-facts.pdf [https://perma.cc/7CLC-URTK] (depicting a large demand for almonds worldwide).

pistachios, produces $8.5 billion a year.[175] This is about eighteen percent of the state's total agricultural revenue.[176]

Almonds have fared reasonably well in the drought.[177] Production in 2015 was down only four percent from 2014 levels, but the world price is dropping.[178] The future does not look as rosy, because as GCC intensifies, the "future climate will significantly change the relative suitability of counties within California for perennial agriculture."[179] For example, the number of chill hours necessary for proper bud growth is declining.[180]

World markets have been crueler for cotton.[181] The fate of pima cotton acreage in the San Joaquin Valley illustrates the harsh discipline that the market imposes during a prolonged drought.[182] California pima cotton is in demand for high quality cotton products, especially polo shirts.[183] But, there is currently a world cotton glut, driven in part by the shift to high-

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175 *See* Justin Fox, *Amid a Drought, Cue the Almond Shaming*, BLOOMBERG VIEW (Apr. 7, 2015), http://www.bloombergview.com/articles/2015-04-07/california-s-almond-farmers-have-become-a-target [https://perma.cc/E44G-ANU7] (describing California's control of the world's almond market).

176 *See id.* (examining California's agricultural revenue in terms of walnuts and pistachio production in 2013).

177 *See* Cary Blake, *Drought Takes Toll on 2015 California Almond Crop*, WESTERN FARM PRESS (July 1, 2015), http://westernfarmpress.com/orchard-crops/drought-takes-toll-2015-california-almond-crop [https://perma.cc/L7DT-9QEA] (demonstrating almonds' resilience against drought).

178 *See* Dale Kasler et al., *California Almonds, Partly Blamed for Water Shortage, Now Dropping in Price*, SACRAMENTO BEE (Jan. 30, 2016), http://www.sacbee.com/news/state/california/water-and-drought/article57432423.html [https://perma.cc/E6Y4-RGGG] (arguing China's economic slowdown is partially to blame, and as of early 2016, many almond growers are implementing planting and expansion plans, despite the suggestion that the market will slow new orchards).

179 David B. Lobell et al., *Impacts of Future Climate Change on California Perennial Crop Yields: Model Projections with Climate and Crop Uncertainties*, 141 AGRIC. AND FOREST METEOROLOGY 208, 216 (2006).

180 *See Global Warming and California Agriculture,* UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/ucs-ca-agriculture2.pdf [https://perma.cc/5E8L-CFL7] (explaining that chill hours are decreasing in many areas of California, which are necessary for proper fruit and nut tree growth).

181 *See Cotton: World Markets and Trade,* U.S. DEP'T OF AGRIC. (Sept. 2016), https://apps.fas.usda.gov/psdonline/circulars/cotton.pdf [https://perma.cc/L63A-ARK5] (charting the low market numbers for cotton in 2015–2016).

182 *See* Hiroko Tabuchi, *A Once-Flourishing Pima Cotton Industry Withers in an Arid California*, N.Y. TIMES (Aug. 7, 2015), www.nytimes.com/2015/08/08/business/a-once-flourishing-pima-cotton-industry-withers-in-an-arid-california.htm?_r=o [https://perma.cc/628Y-VYK7] (demonstrating the unfortunate impact the drought has had on pima cotton acreages that was deemed the cotton of choice).

183 *See id*. (listing the various brands that primarily use pima cotton for their clothing).

performance synthetic fabrics from locker rooms to our living rooms.[184] As a result, California cotton acreage has fallen from 306,000 acres in 2011 to around 100,000 acres in 2015, despite farmer shifts from flood to drip irrigation.[185]

A coherent food and water policy might help farmers adapt better to GCC and world community markets, but the United States has resisted the idea.[186] The country has no coherent water or food policies.[187] We are out-of-step with the international water community, which is pushing the concept of water nexii, or interrelationships, which attempts to focus the world's attention on the need for better water management to feed the world's growing population in the face of growing water demands and GGC.[188] For example, European countries are beginning to develop agricultural climate change resilient strategies, but nexus thinking in the United States remains the province of NGOs.[189]

The international nexus of choice is water-food.[190] At this time, nexus theory is still at an abstract level.[191] However, the Food and Agricultural Organization has outlined a three step process to illuminate national

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184 *See* Julie Wernau, *Global Glut Crops up in Cotton*, WALL ST. J. (Jun. 9, 2015), http://wsj.com/articles.global-glut-crops-up-in-cotton-1433863099 [https://perma.cc/QW8J-P8FX] (discussing the different use of cotton).

185 *See* Tabuchi, *supra* note 182 (conveying the difference in total acres planted in a span of four years).

186 *See Towards a Water and Food Secure Future: Critical Perspectives for Policy-makers*, FOOD & AGRIC. ORG. OF THE U.N. 22, 35–36, 39 (2015), http://www.fao.org/nr/water/docs/FAO_WWC_white_paper_web.pdf [https://perma.cc/8R5E-DRP3] [hereinafter *Critical Perspectives*] (demonstrating a global initiative to conserve water by creating food policies that the United States has not developed).

187 *See* 7 U.S.C. § 2204c (2012) (illustrating the incoherent food and water policies in place in the United States).

188 *See generally Critical Perspectives*, *supra* note 186 (reasserting the notion that the United States is in need of following the global water management trend).

189 *See Water and Energy Nexus: A Literature Review*, WATER IN THE WEST 23 (Aug. 2013), http://waterinthewest.stanford.edu/sites/default/files/Water_Energy_Lit_Review_0.pdf [https://perma.cc/XQ67-U2LE] (demonstrating a need for development in agricultural strategies); *see also* Quirin Schiermeier, *Quest for Climate-Proof Farms*, 523 NATURE 396, 396–97 (July 23, 2015), http://www.nature.com/polopoly_fs/1.18015!/menu/main/topColumns/topLeftColumn/pdf/523396a.pdf [https://perma.cc/8KSE-DJWB] (analyzing programs, such as Modelling European Agriculture with Climate Change for Food Security, that will develop measures aimed at making European agriculture more resilient to climate change).

190 *See The Water-Energy-Food Nexus: A New Approach in Support of Food Security and Sustainable Agriculture*, FOOD & AGRIC. ORG. OF THE U.N. 1 (2014), http://www.fao.org/nr/water/docs/FAO_nexus_concept.pdf [https://perma.cc/J594-PFRA] [hereinafter *Water-Energy-Food Nexus*] (asserting the importance of the water, energy, and food nexus).

191 *See id*. at 3 (explaining the nexus theory as a new, useful tool in understanding the "global resource system").

policy choices: (1) the collection of evidence (data) of water use; (2) the development of different impact scenarios; and (3) response options.[192]

The decision of some countries to consider whether they want to use wet or virtual water for food and commodity production is an example of nexus analysis with implications for California.[193] Wet water uses a country's available supply and virtual water substitutes imported food and commodities for national protection.[194] The choice is not all or nothing; a country could decide that certain crops are not sustainable because the water that it consumes is better allocated for alternative uses.[195] The wet versus virtual water choice raises the question of how a country should define its food security goals.[196] In the immediate future,

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[192] *See id*. at 15 (outlining the process needed to view national policy choices in relation to the nexus theory).

[193] *See E-Conference Synthesis, Virtual Water Trade Conscious Choices*, WORLD WATER COUNCIL 3 (Mar. 2004), http://www.worldwatercouncil.org/fileadmin/wwc/Programs/Virtual_Water/virtual_water_final_synthesis.pdf [https://perma.cc/J6J9-QR6Y] (assessing virtual trade in terms of food and goods). The author states:

> Virtual water trade as such is not new; it is as old as there is exchange of food. With the trade of goods, especially food, there is a virtual flow of water from commodity exporting countries (food and manufactured goods) to the countries that import those commodities. Instead of producing these goods themselves, the importing country can utilise this water for other purposes that else would have been necessary for its production. A water-scarce country can import products that require a lot of water for their production rather than producing them domestically. This results in real water savings relieving the pressure on water resources. Importing countries need not be water poor or water short to be receiver of this virtual flow.

Id. See also RICHARD SANDOR ET AL., SUSTAINABLE INVESTING AND ENVIRONMENTAL MARKETS 247 (2015) (describing China and Saudi Arabia's purchase of millions of acres in Africa and Asia to supply their domestic food needs); *see generally* Dennis Wichelns, *The Role of 'Virtual Water' in Efforts to Achieve Food Security and Other National Goals, with an Example from Egypt*, 49 AGRIC. WATER MGMT. 131 (2001) (using Egypt as an example of setting goals to achieve food security).

[194] *See* Martha O. Pagel, *Creative Programs and Projects to Increase Water Supply Mitigation and Mitigation Banking: Strategies for Meeting New Supply Needs in Oregon's Deschutes Basin*, 6 U. DENV. WATER L. REV. 29, 34 (2003) (defining wet water as water from one's own supply); *see also* Stefania Tamea et al., *Global Effects of Local Food-Production Crises: A Virtual Water Perspective,* SCI. REP. 1 (Jan. 25, 2016), http://www.nature.com/articles/srep18803 [https://perma.cc/7J2A-R7SP] (defining virtual water as a substitute important for socio-economic reasons).

[195] *See* M. B. Pescod, *Wastewater Treatment and Use in Agriculture*, FOOD & AGRIC. ORG. OF THE U.N. (1992), http://www.fao.org/docrep/t0551e/t0551e0a.htm#8 [https://perma.cc/UF74-TH8C] (showing countries restrict farmers from planting certain crops because there are better uses for water).

[196] *See Trade Reforms and Food Security: Conceptualizing the Linkages*, FOOD & AGRIC. ORG. OF THE U.N. 27 (2003), http://www.fao.org/docrep/005/y4671e/y4671e00.htm [https://perma.cc/W3XM-2B4G] (defining food security as a multi-faceted term, encompassing national and international dimension).

California water use will be potentially further stressed by nexus analysis.[197] Countries such as China, Japan, and United Arab Emirates are already growing alfalfa in California.[198] Saudi Arabia's largest dairy owns 1790 acres in the Palo Verde Valley along the Colorado.[199] The area was selected because land landowners have an 1877 priority to Colorado River water.[200]

B. Level Two Strategies

As GCC intensifies, rural, urban, and wild landscapes will change more rapidly and not often for the better.[201] This raises a long-standing question: does an arid climate pose limits on human settlement? As the post-Civil War settlement of the West accelerated, scientists began to ask: how much settlement can an arid or semi-arid region support?[202] Politicians and settlers soon squashed this heresy and answered the posed question with a resounding none, meaning that settlement as a whole was

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197 *See Water-Energy-Food Nexus*, *supra* note 190, at 3 (depicting the complexities of the nexus analysis that assist in utilizing resources affectively).

198 *See* Rick Mooney, *The World Wants Our Hay*, PROGRESSIVE FARMER (Feb. 2015), http://dtnpf-digital.com/article/The_World_Wants_Our_Hay/1907221/242298/article.html [https://perma.cc/BW4C-MND8] (explaining other countries' use of California land to grow crops).

199 *See Saudi Arabia's Largest Dairy Company Buys Land in Palo Verde Valley for the Water Rights*, CAL. WATER NEWS DAILY (Mar. 30, 2016), http://www.californiawaternews daily.com/drought/saudi-arabias-largest-dairy-company-buys-land-in-palo-verde-valley-for-the-water-rights [https://perma.cc/R8CT-MKRJ] (establishing the ownership of land in the Palo Verde Valley).

200 *See id*. (stating in 1877, residents had priority over those living in Los Angeles and San Diego to land and water rights).

201 *See* Matthew Kahn, *How Can Los Angeles Adapt to Coming Climate Change?*, CAL. WATER NEWS DAILY (Sept. 3, 2010), http://www.scientificamerican.com/article/los-angeles-adapt-to-climate-change/ [https://perma.cc/B9HV-WMJL] (suggesting California's urban amenity values will decline due to higher temperatures and the return of serious smog). The article supports this notion by stating:

> What jumps out from this analysis is that areas with cool summers and warm winters command a huge real estate price premium. There are relatively few such areas (mostly in California), and they are in high demand. Climate change is predicted to strip away much of California's climate uniqueness, and therefore will strip away the housing price boost that comes with that climate. Mean July temperatures close to 90 degrees F by the late twenty-first century will force down relative real estate prices to reflect underlying changes in climate amenities.

Id.

202 *See* Reed W. Bailey, *Climate and Settlement of the Arid Region*, YEARBOOK OF AGRIC. 188, 190 (1941), https://naldc.nal.usda.gov/naldc/download.xhtml?id=IND43893765&content=PDF [https://perma.cc/QN8B-7UZ3] (recognizing the question of whether arid or semi-arid climates pose limits on settlement).

not supported by the region.[203] The dominant view was that science and technology do not place limits on western settlement because we can dam, air condition, and innovate our way to unlimited growth.[204] Thus, the primary Level II strategy has been large-scale water infrastructure.[205]

1. New Era of Supply Augmentation: Desalinization, Dam Building, and a Second Look at "Dirty" Water

During the first three quarters of the twentieth century, national water policy was characterized by the construction of large multipurpose dams, reservoirs, and water distribution systems.[206] Under pressure from fiscal conservatives and environmentalists, the Big Dam Era ended in the 1970s.[207] For example, California's last major dam and reservoir, New Melones, was completed in 1979, although a number of smaller dams have been built by local districts.[208] Proponents of a new era of large-scale water project development argue that GCC provides a compelling rationale for a new "supply augmentation" era.[209] Dams are now on the political agenda in California and other western states.[210] In 2014, California voters approved a $7.12 billion water initiative, of which $2.7 billion is allocated to new storage.[211] However, if a new dam building era emerges, it will not be on the scale of the Big Dam Era. The best sites for dams indicate that

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203 *See id.* at 193–95 (demonstrating that settlers favor arid climates, yet settlers may settle in any location due to technological advances).

204 *See* A. Dan Tarlock, *A Brief Examination of the History of the Persistent Debate about Limits to Western Growth*, 10 HASTINGS WEST-NORTHWEST J. ENVTL. L. & POL'Y 155, 156–57 (2004) (describing the technological advances that have broken limitations on settlement because of climate).

205 *See supra* Part III.B (explaining Level II strategies and their benefits).

206 *See* David P. Billington et al., *The History of Large Federal Dams: Planning, Design, and Construction in the Era of Big Dams*, U.S. BUREAU OF RECLAMATION 3 (2005), http://www.usbr.gov/history/HistoryofLargeDams/LargeFederalDams.pdf [https://perma.cc/8N9V-GTKB] (examining the national water policy).

207 *See generally* GERALD HARGADINE, FLUID ARGUMENTS: FIVE CENTURIES OF WESTERN WATER CONFLICT (Char Miller ed. 2001).

208 *See History*, U.S. BUREAU OF RECLAMATION (Feb. 5, 2016), http://www.usbr.gov/mp/ccao/newmelones/history.html [https://perma.cc/V3ZJ-9DJ8] (providing the history of the New Melones dam and reservoir).

209 *See* Mohamed A. Dawoud, *The Role of Desalination in Augmentation of Water Supply in GCC Countries*, 186 DESALINATION 187, 191 (2005) (describing the GCC and its rationale on integration of supply augmentation).

210 *See* Sandra K. Davis, *The Politics of Water Scarcity in the Western States*, 38 SOC. SCI. J. 527, 531 (2001) (demonstrating how dams are on the political agenda of western states).

211 *See* Sean Creadick & Patrick Lewis, *Proposition 1: Water Quality, Supply, and Infrastructure Improvement Act of 2014*, 12 CAL. INITIATIVE REV. 1, 2 (Nov. 4, 2014), http://www.mcgeorge.edu/Documents/Publications/Mergedfinal2014.pdf [https://perma.cc/6WCB-GENK] (outlining Proposition 1 and expanding upon the consequences resulting in passing or rejecting it).

the amount of potential supply augmentation is small compared to the cost, and GCC exposes dams to large evaporation and other losses.[212]

Perhaps the most promising sources of new water will come from existing sources that have been rejected for health or economic reasons or were not seen as technologically feasible, developable sources of water.[213] Treated waste water is the best potential source.[214] Orange County, California has led the way in blending treated waste water with potable aquifer supplies.[215] Ocean desalination is another source that has been touted in the state for decades, but the cost has always been too high.[216] Advances in technology and shortages of water have encouraged substantial private and public investment in arid regions, including California.[217] In December 2015, the world's largest plant opened north of San Diego.[218] The privately funded one billion dollar plant will provide San Diego with fifty million gallons per day; this will supply ten percent of the city's water needs at a rate double those charged by the

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212 *See* Abraham Lustgarten, *Unplugging the Colorado River*, N.Y. TIMES (May 20, 2016), http://www.nytimes.com/2016/05/22/opinion/unplugging-the-colorado-river.html?_r=0 [https://perma.cc/K6F5-6GJM] (illustrating loss and development of dams); *see also* Justin Gillis, *California Wants to Store Water for Farmers, but Struggles over How to Do It*, N.Y. TIMES (Dec. 12, 2015), http://nytimes.com/2015/12/22/science/california-wants-to-store-water-for-farmers-but-struggles-over-how-to-do-it.html?smid=pl-share [https://perma.cc/KQ5L-2BLQ] (explaining that the best areas in California have been developed).

213 *See* G. Wade Miller, *Integrated Concepts in Water Reuse: Managing Global Water Needs*, 187 DESALINATION 65, 68 (2006) (arguing certain methods for reusing water are not used because of the health concerns present).

214 *See* Kieron Monks, *From Toilet to Tap: Getting a Taste for Drinking Recycled Waste Water*, CNN (Nov. 17, 2015), http://www.cnn.com/2012/05/01/world/from-toilet-to-tap-water [https://perma.cc/85LB-TZC2] (exemplifying treated waste water as good source for water).

215 *See What We Do*, ORANGE CTY. WATER DIST., http://www.ocwd.com/what-we-do/ [https://perma.cc/9QX4-E2NP] (providing that Orange County's ground water replenishment system is the world's largest advanced water purification system related to portable reuse).

216 *See* Jessica Schroeder, *Maximizing the Benefit of Desalination in California*, 39 ENVIRONS ENVTL. L. & POL'Y J. 141, 143 (2016) (noting that experts have advocated for desalination in California, but opponents have claimed that the technology's cost is too high).

217 *See* Rich Smith, *5 Desalination Companies That Could End California's Once-in-500-Years Drought*, MOTLEY FOOL (Mar. 1, 2014), http://www.fool.com/investing/general/2014/03/01/5-desalination-companies-that-could-end-california.aspx [https://perma.cc/U9HE-8Y6R] (explaining the vast amount of investment opportunities in California depend on how California chooses to solve its current drought problem by leveraging the prime location next to the Pacific with a nearly unlimited supply of potential clean water through the process of desalination).

218 *See* Bradley J. Fikes, *State's Biggest Desal Plant to Open: What It Means*, SAN DIEGO UNION-TRIB. (Dec. 13, 2015), http://www.sandiegouniontribune.com/news/environment/sdut-poseidon-water-desalination-carlsbad-opening-2015dec13-htmlstory.html [https://perma.cc/5NJ9-8SB3] (providing the final cost for the budgeting project of San Diego County's desalination plant was $1 billion).

Metropolitan Water District.[219] However, if permanent conservation takes hold, the question arises: how much desalination can California support at rates that will encourage private and public investment?

2. Going Deeper: Reimaging a GCC-Changed Landscape

Science and technology have created the modern West, but will this strategy be adequate to the stresses that GCC will place on an already stressed landscape?[220] One way to address this question is to ask if there are any lessons to be derived from the largely ignored critics of unlimited, unconstrained growth in harsh, variable climates.[221]

The patron saint of limits thinking is John Wesley Powell, who gained fame as the first person to navigate Colorado through the Grand Canyon.[222] His fascination with the settlement of an arid region led to efforts to design a rational land and water policy despite the highly variable water supplies.[223] Powell's approach was unique in that:

> [a]lmost alone among his contemporaries he looked at the Arid Region and saw neither desert nor garden. What he saw was a single compelling unity that the region possessed: except in local islanded areas its rainfall was less than twenty inches a year, and twenty inches he took, with slight modifications for the peculiarly concentrated rainfall of the Dakotas, to be the minimum needed to support agriculture without irrigation.[224]

Powell's famous 1876 Report on the Lands of the Arid Region concluded that only a small percentage of the West was irrigable.[225]

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219 *See* Amanda Little, *Can Desalination Counter the Drought?,* NEW YORKER (July 22, 2015), http://www.newyorker.com/tech/elements/can-desalination-counter-the-drought [https://perma.cc/D4FF-5F9W] (expanding on the specifications of the newly opened facility that will pump over a hundred million gallons of ocean water every day).

220 *See supra* Part I.A (explaining the stresses GCC places on varying climates and landscapes).

221 *See supra* Part I.B (examining the limitations of GCC when applied in an arid climate).

222 *See* WALLACE STEGNER, BEYOND THE HUNDREDTH MERIDIAN: JOHN WESLEY POWELL AND THE SECOND OPENING OF THE WEST 85–87 (1954) (explaining Powell's dangerous journey through the mountains by mapping out the Colorado River for miles on foot).

223 *See id.* at 24 (discussing how Powell's exploration through the Colorado River persuaded Congress to pass special legislation in the newly mapped area in 1868).

224 *Id.* at 223–24.

225 *See* J. W. POWELL, REPORT ON THE LANDS OF THE ARID REGION OF THE UNITED STATES, WITH A MORE DETAILED ACCOUNT OF THE LANDS OF UTAH 81–82 (2d ed., 1879) (observing throughout the Arid Region the extent of irrigable land is limited in its growth by its water supply).

Impressed by the Mormon communitarian society that flourished in Utah in the 1870s, he recommended that small-scale colonies should be located only in hydrologic basins with decent water supplies and sustained by cooperative irrigation districts.[226] However, the federal government and the West rejected Powell's ideas and launched the federal reclamation program, which grew into a series of large dams and irrigation projects that vein the West today.[227] Powell's plea for small-scale development influenced academics, such as Walter Prescott Webb and the great chronicler of the West, Wallace Stegner, but not politicians.[228] Still, GCC has reintroduced the limits question and previously unasked questions, but the barriers to implementing limits are formidable.[229] The reasons are legal, scientific, and political.[230]

The major legal constraint is the implied right to travel.[231] We also do not know how we can adapt to GCC and mitigate its adverse impacts.[232] Just as states cannot hoard natural resources, they cannot close their

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[226] *See id.* at 128 (noting the Mormon Church's control in determining the best use of the water rights for the betterment of the general welfare of their society); *see also* DONALD WORSTER, A RIVER RUNNING WEST 352 (2001) (providing that Mormons in 1870 did not have established independent ranches like other Americans at the time; however, the Mormons created a village herd system where each owner provided only a few head of cattle and herded them onto nearby bench lands or mountain slopes to graze while having the added benefit of joint supervision).

[227] *See* Billington et al., *supra* note 206, at 193–94 (2005) (expanding on the notion that the federal government would be in charge of the numerous new reclamation programs because local governments were too small to handle the problem and presumably private governments had failed).

[228] *See* WALTER PRESCOTT WEBB, THE GREAT PLAINS vi (1931) (explaining Prescott's views on Powell's findings from the humid and timbered regions as a new phase of Aryan civilization, which influenced his writing on early Western life and institutions); *see generally* J. DONALD HUGHES, AN ENVIRONMENTAL HISTORY OF THE WORLD: HUMANKIND'S CHANGING ROLE IN THE COMMUNITY OF LIFE 209–11 (2001) (discussing sustainable development as intrinsically impossible). This thinking can be traced in New Mexico water publications. *See* NEW MEXICO ENVTL. L. CTR., LIVING WITHIN OUR MEANS: A WATER MANAGEMENT POLICY FOR NEW MEXICO IN THE 21ST CENTURY 14 (1992) (stating that the growing population in the West led to a competitive environment for allocating water resources); IAN L. MCHARG, DESIGN WITH NATURE 31 (1992) (expanding on the concept that sometimes economic projects are more aesthetically pleasing than functional).

[229] *See supra* Part II.A (explaining the unpredictable aspects of Mother Nature, which will always be a limitation on GCC).

[230] *See supra* Part II.A (articulating that, because of the weather's unpredictable nature, w scientific advancements are not as progressive as they otherwise might be).

[231] *See supra* Part II.A (observing that the unpredictable aspects of Mother Nature make it difficult for political action to be taken because people may be prone to traveling or living in a warm climate).

[232] *See, e.g.*, Cal. Exec. Order No. B-29-15 (2014) (suggesting a reduction in water usage for cities and towns in California to prevent future drought issues).

borders to interstate migration.[233] States cannot deflect population to other states and thus, refuse to accommodate growth by refusing entry to new residents.[234]

The scientific problem presented is that plausible, scary landscape change scenarios exist, but the scale, intensity, or timing of these scenarios is unknown.[235] How to adapt to GCC and mitigate its adverse impacts is also unclear.[236] The best that the California Department of Water Resources, which has been in a leader in integrating climate change into water policy planning, can do is to state that "California's future hydrologic conditions will likely be different from patterns observed over the past century–although the precise causes, extent, and timing of the changes remain uncertain."[237] The longer the time horizon, the greater the disparity between investing current resources in benefits that will occur, if ever, in the future.[238] This makes it difficult, if not impossible, to induce governments to act.[239] In addition, as long as science and technology can support development, the fewer incentives there are to consider alternative landscape and economic scenarios.[240] Even Wallace Stegner, the great proponent of a small-scale West, said toward the end of his life that "California . . . has the water and the climate and the soil to support a

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233 *See* Edwards v. California, 314 U.S. 164, 167 (1941) (explaining that a state cannot bar entry of "indigent" non-residents); *see also* New England Power Co. v. New Hampshire, 455 U.S. 331, 334, 336, 338 (1982) (observing that absent federal oversight, it would be questionable for a state to constitutionally restrict interstate trade in hydroelectric power).

234 *See supra* Part II.A–B (discussing the history of California's water law and the necessity of considering unpredictable natural disasters).

235 *See, e.g.*, Kahn, *supra* note 201 (providing the effects of higher temperatures and smog on California).

236 *See supra* Part II.A (recognizing California's status as a state that is highly vulnerable to the adverse impacts of GCC because it is a wetter, warmer climate with less net water availability).

237 *Global Climate Change and Its Effects on California Water Supplies*, IMPACT SCI., INC. 2 (Feb. 2009).

238 *See id*. at 6–7 (stating over a prolonged period of time, warmer winters in varying landscapes will increase the amount of runoff available for groundwater recharge, which further supports the scientific research behind GCC).

239 *See* Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153, 1156–57 (2009) (noting because the U.S. government has three branches, it can be difficult for them all to work together to achieve climate change reform).

240 *See id*. (observing political action is limited by scientific support for climate change legislation).

population like Japan, if it has to."[241] Still, the legacy of the limits debate may help frame the hard questions GCC raises but politicians fear.[242]

3. A Modest Adaptation Step: Living with a Reduced Water Budget

For decades, very little connection between land use and water supply decisions existed.[243] The net result provided that cities did not have to worry about matching growth to available water budgets.[244] California has potentially introduced climate-related constraints on development by shifting the partial responsibility to developers to demonstrate that new developments have an adequate future water supply, which includes GCC risks.[245] In 1995, California enacted legislation, primarily in response to the rapid and dispersed urban growth and conversion of prime agricultural land in northern California and the San Joaquin Valley to residential use, to require cities to have a firm water supply plan in place before large, new developments are approved.[246] The statute, unlike Arizona's adequate water supply statute, does not impose a de facto duty on cities to acquire sufficient water rights and was not initially enforced.[247]

The state legislature tightened the law in 2001, prohibiting approval of tentative subdivision maps, parcel maps, or development agreements for subdivisions of more than 500 units, unless there is a "sufficient water supply."[248] If the supplier has less than 5000 connections, the adequate supply requirement applies to any subdivision that will amount to a ten percent increase in service connections.[249] Sufficient supply is defined as the total supply available during "normal, single-dry, [and] multiple-dry

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241 WALLACE STEGNER & RICHARD W. ETULAIN, CONVERSATIONS WITH WALLACE STEGNER ON WESTERN HISTORY AND LITERATURE x (Rev. ed. 1983).

242 *See* Lazarus, *supra* note 239, at 1156–57 (explaining political action often requires scientific support before meaningful legislation can ever pass).

243 *See id.* (noting historically, land use and water planning were done separately from one another in the United States in that water was allocated by state agencies and local officials provided for land use).

244 *See* WET GROWTH: SHOULD WATER LAW CONTROL LAND USE? 192 (Craig Anthony Arnold ed. 2005) (covering the history of the disconnect between water supply decisions and land use and the recent efforts to integrate water provision and land use controls).

245 *See supra* Part II.A.4 (discussing the change in climate change restraints).

246 *See* CAL. GOV'T CODE § 66473.7 (2005) (examining the water supply historical record to observe the changes over a twenty-year period).

247 *See id.* (recognizing that California requires written verification from the public water supplier validating the presence of sufficient water conditions).

248 *See* CAL. WATER CODE §§ 10910–10915 (2016) (providing the requirement of sufficient water supply for development); *see, e.g.*, Symposium, *Real Water: California's Land Use Water Law Turns 10*, 4 GOLDEN GATE U. ENVTL. L.J. 1, 4 (2010) (explaining the need to analyze previous land-use legislative decisions to ensure better decision today).

249 *See* CAL. GOV'T CODE § 66473.7 (discussing the supply requirements as applied to subdivisions).

years over [a] 20-year projection."[250] To calculate this, the supplier must include a number of contingencies, such as the availability of water from water supply projects, "federal, state, and local water initiatives such as CALFED," and water conservation.[251] Enforcement of the law is connected to the water suppliers' duty to create urban water management plans.[252] Water supply assessments must either be consistent with these plans or meet the available water supply criteria.[253] Assessments may trigger a duty to acquire additional water supplies.[254]

These duties will be enforced primarily under the California Environmental Quality Act ("CEQA").[255] The process is intended to allow objectors to probe the underlying assumptions and reliability of the data on which the assessments are made.[256] This could be a serious impediment to business as usual, as evidenced by CEQA litigation.[257]

During the drought, the extension of the law to place a moratoria on all new building was suggested.[258] Not surprisingly, the building industry argued that this would push California housing prices higher and higher.[259] Instead, the building industry proposed incentives to retrofit

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250 Eric N. Robinson, *Show Me The Water!: Water Supply Impact Analysis in an Era of Drought and Supply Uncertainty* (Feb. 5, 2016), http://www.mcgeorge.edu/Documents/Conferences/robinsonPresentation.pdf [https://perma.cc/C3YN-LX7Q].

251 CAL. GOV'T CODE § 66473.7(a)(2)(D).

252 *See* David H. Getches & A. Dan Tarlock, *Water Law and Management: An Urbanizing and Greener West Copes with New Challenges*, *in* THE EVOLUTION OF NATURAL RESOURCES LAW AND POLICY 323 (2010) (indicating water supply management and assessments may require a duty to acquire supplementary water supplies).

253 *See* CAL. WATER CODE § 10910(d)(1) (providing what a water supply assessment must include).

254 *See* § 10911(a) (describing the responsibilities of a water system, city, or county if a water supply assessment concludes it has insufficient water supplies).

255 *See Frequently Asked Questions about CEQA*, CAL. NAT. RES. AGENCY (2014), http://resources.ca.gov/ceqa/more/faq.html [https://perma.cc/QLL8-GK6C] (recognizing California Environmental Quality Act ("CEQA") requires state and local government agencies to identify the environmental impact of their actions and orders changes for the betterment of the environment, if necessary).

256 *See id.* (stating there are both procedural and substantive requirements imposed by the environmental review under CEQA).

257 *See* Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova, 150 P.3d 709, 735–38 (Cal. 2007) (explaining the California Supreme Court issued a major decision that will guide the application of CEQA during future water supply projections).

258 *See* Haya El Nasser, *Building Boom amid Disaster: New Housing Springs up during Calif. Drought*, ALJAZEERA AM. (Dec. 11, 2015), http://america.aljazeera.com/articles/2015/12/11/california-drought-has-not-slowed-development.html [https://perma.cc/7L2C-WS2P] (indicating the steps taken by Pismo Beach to protect the water supply during the drought).

259 *See id*. (providing that housing will always be in demand, even during a drought, and as a result, the prices for housing are high).

older homes and to continue to support more intense, concentrated urban development in the face of local resistance.[260]

IV. CLIMATE CHANGE AND THE MIDWEST

The Midwest will experience GCC that will impact both agriculture and the environment.[261] Crops will benefit from a longer growing season, but extreme events may offset some of these benefits.[262] Crops and livestock may face heat stress as summer evaporation dries out the soil, which is not good for an area with limited supplemental irrigation capacity.[263] This is evidenced by:

> [a] detailed study of the expected effects of climate change on crop yields in five Midwest states shows that corn yields in Indiana may decline as much as 50 percent by the middle of this century under a variety of scenarios and assumptions. For soybeans, a crop that benefits more than corn from CO2 fertilization, results were mixed, with some scenarios showing small yield gains and others showing decreases.[264]

The Great Lakes face environmental stresses from GCC that will likely worsen a host of existing problems in them.[265] These problems include changes in the range and distribution of important commercial and recreational fish species, increases in invasive species, declining beach health, and more frequent harmful algae blooms.[266] However, declines in ice cover on the Great Lakes may lengthen the commercial shipping season.[267]

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260 *See id*. (maintaining development needs to occur in the right areas).

261 *See Midwest*, MIDWEST NAT. CLIMATE ASSESSMENT (2014), http://nca2014.globalchange.gov/report/regions/midwest, [https://perma.cc/WRS7-8PAJ] (explaining the significant impact GCC will have on the Midwest because the region has experienced shifts in population, air and water pollution, and landscape changes).

262 *See id.* (discussing the agricultural impact the Midwest will face due to longer growing seasons and rising carbon dioxide levels, which will increase the yields of crops).

263 *See id.* (explaining climate change can either slow down or intensify the growth variables pertaining to vegetation in urban environments).

264 *Confronting Climate Change in the U.S. Midwest: Indiana*, UNION OF CONCERNED SCIENTISTS 8 (July 2009), http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/climate-change-indiana.pdf [https://perma.cc/8J4F-V5YJ] (internal citations omitted).

265 *See id.* at 7 (analyzing the unfamiliar concept that water levels in the Great Lakes are expected to drop in the summer and winter season).

266 *See id*. (discussing the far-reaching effects of declining water levels of the Great Lakes).

267 *See Climate Change to Profoundly Affect the Midwest, New Report Says*, MICH. NEWS (Jan. 18, 2013), http://www.ns.umich.edu/new/releases/21105-climate-change-to-profoundly-

The basic lesson provided by California's adaptation to the 2012–2015 drought teaches that it is better to be proactive than reactive, otherwise the market will dictate adaptation and it will be difficult to address other stresses.[268] Several states have developed drought adaptation strategies that identify steps that both promote adaptation and provide more immediate benefits regardless of GCC.[269] An element of any drought adaptation strategy is a comprehensive water use allocation regime that creates firm use entitlements.[270] Firm entitlements can help define the risks of drought and encourage pre-drought adaptation through more efficient water use and crop selection because they define the risks of curtailment during shortages.[271] During a drought, clear entitlements can also facilitate water transfers.[272]

affect-the-midwest-new-report-says [https://perma.cc/D9XX-WTSG] (recognizing the impact of climate change on commercial shipping in the Great Lakes).

[268] *See supra* Part II.A.2–3 (observing the multiple impacts the drought can have on a landscape).

[269] *See Adaptation Examples in the Midwest,* EPA (Feb. 23, 2016), https://www3.epa.gov/climatechange/impacts-adaptation-renamed/midwest-adaptation.html. [https://perma.cc/398D-ADBB] (highlighting Illinois, Minnesota, and Wisconsin's climate change adoption planning strategies).

[270] *See id.* (observing that having a drought response plan helps city planners identify the best areas to implement future projects).

[271] *See id* (explaining that having a strategy helps to address vulnerabilities related to a state's climate change).

[272] *See id.* (addressing the overall benefits of collaborative efforts between state and federal agencies).