ARTICLES

WESTERN WATER LAW AND THE CHALLENGE OF CLIMATE DISRUPTION

BY
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In the past six decades, the West has had to adapt to three challenging changed conditions, all of which have impacted the allocation and use of water and thus western water law. First, the West has transitioned from a commodity production colony to the most urbanized region in the country. Second, the environmental movement created the demand for legally protected instream uses. Third, fiscal and environmental pressures ended the Big Dam Era, and thus, the federal government no longer back-stops state water rights with new, subsidized carry-over storage reservoirs. Today, the West must adapt to a fourth changed condition, global climate change or global climate disruption. Previous adaptation strategies are an imperfect guide to coping with climate disruption, which projects a wetter, warmer West with less dependable available water supplies to supply a growing population, high-value agricultural areas, and the conservation of aquatic ecosystems. Adaptation planning is well underway in the West, but comparatively little attention has been given to how the projected changed climate will impact western water law. This Article surveys four possible impacts as the competition among cities, farms, and fish increases. We can leave prior appropriation alone because it is a complete risk-allocation system which will force the necessary allocation changes. In the alternative, we can negotiate around old

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prior by voluntary reallocations to provide more water for cities and instream uses. Aggressive public trust litigation can also reallocate water, primarily for aquatic ecosystems. Finally, we can abolish prior appropriation and replace it with tradable volumetric entitlements. The Article concludes that prior appropriation will remain the allocation framework for the foreseeable future. But, it will be increasingly supplemented by market pressures combined with innovative out-of-the-box solutions which will push agriculture to consider alternative cropping patterns, less intensive uses, and new sharing patterns.

I. A PERSONAL NOTE ON THE FASCINATION WITH RUNNING WATER

Let me begin on a personal note. I first became fascinated with flowing water when I visited my mother's relatives in Provo, Utah. Crystal clear water flowed along small concrete canals between the sidewalks and the streets, something that I had never seen growing up in the San Francisco Bay Area. My relatives explained the history of Mormon settlement in Utah and the crucial role that irrigation ditches played in the state's development.[1] My interest in water lay dormant until my second year of law school when it took me two weeks to discover that an excruciatingly boring assigned law

[1] In the 1950s, Provo's ditches were a remnant of a time when there was little divide between most Utah cities and irrigated farms. *See* LeRoy W. Hooton, Jr., *Salt Lake City Old Water Conveyance Systems*, SALT LAKE CITY (June 23, 2007), https://perma.cc/UF8G-2QW9.

review note topic was preempted. With trepidation, I asked for a replacement, and the editor-in-chief told me that all she had was a Colorado water rights case that no one wanted, recently sent down by a new professor. I grabbed it, and a fifty-year-plus fascination with water law was launched.

The case brought me to Charlie Meyers, first as a research assistant on his landmark work on the Colorado River[2] and then to life-long friendship until his premature death in 1984. My interest deepened during a hospital stay my third year when a family friend gave me a new edition of John Wesley Powell's *Report on the Lands of the Arid Region of the United States*.[3] I decided to make a career around the West's use of its natural resources. My first step was to join the Sierra Club. In those days, you had to have a letter from a member. Charlie told me that a "relatively" well-known author and member, Wallace Stegner, taught in the English Department. I made an appointment to see him, laid out a half-baked idea of linking law and the preservation of free-flowing rivers. He agreed to sponsor me and wished me luck.

Armed with my Sierra Club membership, I asked Charlie if I could write a paper on the subject for his water law course. I still remember his terse, Texas-twang response: "I don't think there's much there but OK." There was enough to write the paper, which only earned a B-plus, but it became my first published article when I ended up at the University of Kentucky two years later.[4] The problem of securing what we now call "environmental flows" has remained one of the leitmotivs of my career and has taken me to all the continents except Antarctica. In the 1980s and 1990s, through work with the Water Science and Technology Board of the National Academy of Sciences, I became aware of the problem of climate change, or climate disruption (CD) as I now prefer to call it,[5] and what it might do to water, developing a second and related leitmotiv of my career.

II. THE CHANGED WEST: 1960S TO THE PRESENT

In this Article, I will examine the four major changed conditions that have impacted the West and water policy and law starting in the late 1960s. Solely due to the accident of my birth, my career has spanned the urbanization of the West, the twilight and end of the big dam era, the era of

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2 *See generally* Charles J. Meyers, *The Colorado River*, 19 STAN. L. REV. 1 (1966). In 2016, I had the pleasure of giving my signed reprint to Jason Anthony Robinson, Assistant Professor University of Wyoming School of Law, who used the article as a jumping off point for his review of subsequent developments. *See* Jason Anthony Robison, *The Colorado River Revisited*, 88 U. COLO. L. REV. 475 (2017).

3 JOHN WESLEY POWELL, REPORT ON THE LANDS OF THE ARID REGION OF THE UNITED STATES: WITH A MORE DETAILED ACCOUNT OF THE LANDS OF UTAH (Wallace Stegner ed., 1962).

4 *See generally* A. Dan Tarlock, *Preservation of Scenic Rivers*, 55 KY. L.J. 745 (1967).

5 The term "climate disruption" originated with John Holdren, President Obama's Science Advisor. *See* JOHN P. HOLDREN, GLOBAL CLIMATE DISRUPTION: WHAT DO WE KNOW? WHAT SHOULD WE DO? (2007), https://perma.cc/4N8P-TGXT; *Director John P. Holdren*, WHITE HOUSE: PRESIDENT BARACK OBAMA, https://perma.cc/5HHM-864N (last visited Jan. 27, 2018).

environmental protection and reallocation of water, and now the challenge of CD. I will first look backwards at the impact that the first three changes have had on western water law. Then, I will look forward and see what lessons, if any, adaptation to these changes have for CD adaptation. Finally, I sketch four possible, non-exhaustive CD adaptation strategies for western water law. I do not address the deeper questions of whether CD will force the West to revisit the long-running debate about the limits, if any, that the West's geography and limited water resources place on human settlement,[6] and what a truly radical new water law and landscape policy might look like.[7]

In the early 1960s, outside the Pacific Coast, the West was still a relatively sparsely populated eastern commodity colony.[8] The assumption was that it would continue as such, supported by massive, necessary federal water resources investment.[9] Instead, the West and the federal role in water management changed dramatically in three ways. First, the West became the most urbanized region of the country.[10] Thanks to air conditioning and the internet, its generally harsh climate became a non-factor in settlement.[11] Second, the environmental movement, fueled by urbanites taste for beauty

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6 See DONALD WORSTER, A RIVER RUNNING WEST: THE LIFE OF JOHN WESLEY POWELL (2001), for a full account of the first prophet of the possible limits on the settlement of the West and his unsuccessful efforts to convince the federal government to develop a rational settlement policy for the West. I made a stab at the modern legacy of John Wesley Powell in A. Dan Tarlock, *A Brief Examination of the History of the Persistent Debate About Limits to Western Growth*, 10 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 155 (2004).

7 See JOE WHITWORTH, QUANTIFIED: REDEFINING CONSERVATION FOR THE NEXT ECONOMY 151–54 (2015), for what such a water policy and law might look like.

8 *Compare* BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, CENSUS OF POPULATION: 1960, at 1-16 tbl.9 (1960), *with* U.S. CENSUS BUREAU, U.S. DEP'T OF COMMERCE, 2010 CENSUS OF POPULATION AND HOUSING 11 (2013) (showing an increase of the Mountain West region's population from 6,855,060 in 1960 to 22,065,451 in 2010).

9 *See, e.g.*, Colorado River Basin Project Act, 43 U.S.C. § 1541 (2012) (allocating funds to "(1) commercial power, (2) irrigation, (3) municipal and industrial water supply, (4) flood control, (5) navigation, (6) water quality control, (7) recreation, (8) fish and wildlife, (9) the replenishment of the depletion of Colorado River flows available for use in the United States occasioned by performance of the Water Treaty of 1944 with the United Mexican States, and (10) any other purposes authorized under the Federal reclamation laws" (citation omitted)). Prior to World War II, the West was a production and leisure colony for the eastern two-thirds of the country. Its economy was based on dry land and irrigated agriculture, hard rock and hydrocarbon mineral extraction, livestock ranching, timber production, and tourism to the new national parks and forests. MICHAEL P. MALONE & RICHARD W. ETULAIN, THE AMERICAN WEST: A TWENTIETH CENTURY HISTORY 11–53 (1989).

10 *See* Press Release, U.S. Census Bureau, Growth in Urban Population Outpaces Rest of Nation (Mar. 26, 2012), https://perma.cc/M2UY-SZF6 ("Of the nation's four census regions, the West continued to be the most urban, with 89.8 percent of its population residing within urban areas."); *see also* ERIC H. MONKKONEN, AMERICA BECOMES URBAN: THE DEVELOPMENT OF U.S. CITIES & TOWNS 1780–1980, at 80 tbl.3 (1988) (showing that the West established the most towns in the United States during the 1960s that would later reach a population of 100,000 by 1970).

11 *See, e.g.*, TOM R. REX, DEVELOPMENT OF METROPOLITAN PHOENIX: HISTORICAL, CURRENT AND FUTURE TRENDS 3 (2000) (attributing growth in Phoenix, Arizona in part to improvements in air conditioning).

and recreation,[12] led to the withdrawal of many undammed stretches of rivers from development[13] and to the establishment of minimum environmental flows on others.[14]

The second change helped produce the third: the end of new federally subsidized or funded dams and the federal government's retreat from its dominant role in the first six decades of the 20th century in western water policy.[15] This change resulted from the fusion of environmentalism and fiscal conservatism. Environmental activists, led by David Brower of the Sierra Club, joined with fiscal conservatives to end large federal water infrastructure investment.[16] Simultaneously, the federal role shifted from builder to regulator. The Clean Water[17] and Endangered Species[18] Acts imposed new regulatory constraints on the exercise of state water rights.[19] Today, the federal government is not powerless, but its main roles are the management of its aging legacy infrastructure[20] and, at least prior to 2017, as a source of credible scientific information and judgment about the challenges facing the ever-growing West in the face of CD.[21] In the process, and in the absence of a federal food policy,[22] substantial blocks of irrigated agricultural became the new "reservoirs" to support urban growth, and water rights began to converge with long-alienable land rights.[23] Fourth, starting in the 1990s, the West has gradually accepted the reality that CD is

12 *See* SAMUEL P. HAYS, BEAUTY, HEALTH, AND PERMANENCE: ENVIRONMENTAL POLITICS IN THE UNITED STATES, 1955–1985, at 90–91 (1987) ("The shift to the suburb often came when younger generations sought surroundings that were more pleasant than those in which they had grown up.").

13 Wild and Scenic Rivers Act of 1968, 16 U.S.C. §§ 1271–1287 (2012).

14 *See infra* note 60 and accompanying text.

15 The history of the Big Dam Era and its demise is told in DAVID P. BILLINGTON ET AL., BUREAU OF RECLAMATION ET AL., THE HISTORY OF LARGE FEDERAL DAMS: PLANNING, DESIGN, AND CONSTRUCTION IN THE ERA OF BIG DAMS (2005), https://perma.cc/RV7Q-HCGQ.

16 *See generally* TOM TURNER, DAVID BROWER: THE MAKING OF THE ENVIRONMENTAL MOVEMENT (2015) (giving a history of David Brower's leadership of and efforts in the environmental movement).

17 Federal Water Pollution Control Act, 33 U.S.C. §§ 1251–1387 (2012).

18 Endangered Species Act of 1973, 16 U.S.C. §§ 1531–1544.

19 *See, e.g.*, PUD No. 1 of Jefferson Cty. v. Wash. Dep't of Ecology, 511 U.S. 700, 719 (1994) (collapsing the distinction between water quantity and quality); United States v. Glenn-Colusa Irrigation Dist., 788 F. Supp. 1126, 1135 (E.D. Cal. 1992) (concluding that state law does not exempt the District from complying with regulations of waterways and endangered species protection within the waterways); *see also* Reed D. Benson, *Avoiding Jeopardy, Without the Questions: Recovery Implementation Programs for Endangered Species in Western River Basins*, 2 MICH. J. ENVTL. & ADMIN. L. 473, 479, 491 (2013) (noting the interplay between state and federal water allocation and management).

20 *Projects & Facilities*, BUREAU RECLAMATION, https://perma.cc/2UJJ-RSVE (last updated Apr. 25, 2017).

21 *See, e.g.*, *Resources, Data, & Multimedia*, U.S. GLOBAL CHANGE RES. PROGRAM, https://perma.cc/Q328-FHGH (last visited Jan. 27, 2018) (providing access to data from thirteen participating federal agencies).

22 *See* Laurie J. Beyranevand & Emily M. Broad Leib, *Making the Case for a National Food Strategy in the United States*, 72 FOOD & DRUG L.J. 225, 231–32 (2017) (explaining the lack of a unified federal strategy for food policy).

23 *See* discussion *infra* Part III.A.

happening and that western landscapes and water budgets face serious risks of negative impacts.[24]

III. INCREMENTAL ADAPTATION

In the early 1960s, prior appropriation rested on a simple catechism that a water right could be perfected by diverting water and putting it to continuous beneficial use within a reasonable period of time.[25] The system was originally designed to support a small-scale irrigation economy,[26] but by the 1960s it had evolved to accommodate three major uses, two consumptive and one non-consumptive. Irrigated agriculture still took the lion's share (86%) of withdrawals, and cities took the rest (5%).[27] With limited exceptions, hydropower was able to use water upstream and release it for downstream consumptive use.[28] Irrigation withdrawals have modestly declined and urban uses increased, but the three major uses account for over 90% of all water use.[29] This relative stability among uses enabled prior appropriation to accommodate reasonably well to the new uses demanded by a changing West and to weather the end of the Big Dam Era.

A. Farms Become Reservoirs

Growing metropolises thrived because they were able to draw on law and economics to move water from farms to urban use. Prior appropriation had long supported urban growth. A water right was not limited to the watershed of origin, as the common law of riparian rights originally did,[30] and courts had long granted cities a de facto "super-preference"[31] to acquire

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24 *See* discussion *infra* Part IV.A.

25 *E.g.*, *In re* Adjudication of the Existing Rights to the Use of All the Water, 55 P.3d 396, 399 (Mont. 2002) (explaining that the system of prior appropriation–based water rights on diversion of the water for a beneficial purpose).

26 *See* ROBERT G. DUNBAR, FORGING NEW RIGHTS IN WESTERN WATERS 81 (1983) (discussing the Colorado Doctrine's origins in the necessity of agricultural irrigation in Colorado's dry climate).

27 WAYNE B. SOLLEY, ESTIMATES OF WATER USE IN THE WESTERN UNITED STATES IN 1990 AND WATER-USE TRENDS 1960–90, at 14 (1997), https://perma.cc/3HBN-FZYY.

28 U.S. ARMY CORPS OF ENG'RS, OUTLOOK FOR THE U.S. ARMY CORPS OF ENGINEERS HYDROPOWER PROGRAM 14 (2011), https://perma.cc/TD3C-A6PN ("Hydropower is generally considered a non-consumptive water use, because water is released downstream where it remains available for other uses.").

29 *See* MOLLY A. MAUPIN ET AL., U.S. GEOLOGICAL SURVEY, CIRCULAR 1405, ESTIMATED USE OF WATER IN THE UNITED STATES IN 2010, at 7 (2014) (explaining that thermoelectric power, irrigation, and public supply cumulatively accounted for 90% of total water withdrawals in the United States).

30 *See* Coffin v. Left Hand Ditch Co., 6 Colo. 443, 447 (1882).

31 For example, cities are exempt from the anti-speculations limitations in prior appropriation which required that water be put to beneficial use within a limited period of time. Washington State recently extended the growing cities doctrine to public universities. Cornelius v. Wash. Dep't of Ecology, 344 P.3d 199, 208 (Wash. 2015). The majority held that the failure of Washington State University (WSU) to use groundwater rights for certificates issued in 1962–1963 was not speculation because "[WSU] is in the unusual position of being unable to predict

water for anticipated future growth.[32] Cities got a big boost from neo-welfare economists. Starting in the late 1960s, economists leveled a devastating critique of prior appropriation and the permanent, Jeffersonian-irrigated agricultural society supported by western water law: seniority locked too much water into low-valued crops.[33] The solution was to turn water rights into marketable property rights so that water could move to higher valued urban uses.[34] Water marketing was endorsed by influential environmental groups such as the Environmental Defense Fund in the 1980s,[35] and cities were able to leverage their superior purchasing power to dewater parts of the rural West:

> [S]eventy-seven percent of all exchanges and sixty percent of all water originates in agriculture. Agriculture-to-urban exchanges are the most numerous, with fifty-six percent of transfers and eighteen percent of all water transferred, at 5,533,394 acre-feet. Urban-to-environmental and combination exchanges also involve considerable amounts of water.[36]

Water marketing has largely ignored social costs "planned" decline of rural areas in many places. A study of the future of irrigated agriculture in northeast Colorado

> projected a loss of approximately 24% (175,000 acres) by 2030 and 68% (500,000 acres) by 2050 of total cropland, exceeding the estimated 33% loss in Colorado's Water Plan while undershooting other predictions of 400,000 acres lost by 2030. The net present value (NPV) of agricultural profit from production across the entire [South Platte River Basin] was about $6.1 billion, whereas sales from water rights purchases totaled about $17.9 billion.[37]

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or plan its own growth because its budget and enrollment targets are largely controlled by the legislature." *Id.* at 212. *See generally* WET GROWTH: SHOULD WATER LAW CONTROL LAND USE? (Craig Anthony (Tony) Arnold ed., 2005) (discussing the interplay between water law, land development, and city planning).

32 The Colorado Supreme Court has tried to limit the preference by tightening the planning duties of cities. *See* Pagosa Area Water & Sanitation Dist. v. Trout Unlimited, 170 P.3d 307, 315 (Colo. 2007) (explaining that public entities must substantiate a non-speculative intent ro appropriate water under a specific plan); *see also* Pagosa Area Water & Sanitation Dist. v. Trout Unlimited, 219 P.3d 774, 777 (Colo. 2009) (finding that a fifty-year planning period was reasonable but that evidence in the record did not support the amounts of water for which the applicant asserted a need). However, the decision has had no impact outside of Colorado.

33 *See generally* L. M. HARTMAN & DON SEASTONE, WATER TRANSFERS: ECONOMIC EFFICIENCY AND ALTERNATIVE INSTITUTIONS (Henry Jarrett et al. eds., 1970) (launching the call for water transfers).

34 *See* Anthony Scott & Georgina Coustalin, *The Evolution of Water Rights*, 35 NAT. RESOURCES J. 821, 921 (1995).

35 NAT'L RESEARCH COUNCIL, WATER TRANSFERS IN THE WEST: EFFICIENCY, EQUITY, AND THE ENVIRONMENT 130–31 (1992).

36 Jedidiah Brewer et al., *Transferring Water in the American West: 1987–2005*, 40 U. MICH. J.L. REFORM 1021, 1039 (2007).

37 André Q. Dozier et al., *Declining Agricultural Production in Rapidly Urbanizing Semi-Arid Regions: Policy Tradeoffs and Sustainability Indicators*, ENVTL. RES. LETTERS, Aug. 8, 2017, at 5–6, 085005, https://perma.cc/DKQ6-5E5Y (citations and footnote omitted).

"In Utah, the land in farms, including harvested cropland and pastureland, declined by 2.5 million acres, or 18 percent, from 1960 to 2008."[38] Colorado lost 850,000 irrigated acres between 1997 and 2012.[39] Between 2007 and 2012, declines in irrigated acreage "exceeded 10 percent in Texas, Colorado, Oregon, New Mexico, and Oklahoma."[40] In contrast, farmers in California have succeeded in holding on to their water and limiting transfers.[41]

B. The New Federal Role: Not Much to Offer Except Bad News

Prior appropriation rights were back-stopped by large federal and state carry-over storage reservoirs.[42] By the end of the 1980s, western states finally realized that the Big Dam Era was over and that they had to adjust to living within existing water budgets.[43] For the Bureau of Reclamation, the lack of a clear mission and money to throw at the states gradually reduced it to one influential player among many in the West.[44] On one level the adjustment was not hard. The dam-building era left the Bureau of Reclamation with 338 reservoirs with a storage capacity of 140 million acre-feet, which still allows it to deliver water to ten million acres of farm land.[45] But to adapt (at least prior to 2017), it has used its diminished influence to play the role of Cassandra, the Trojan Princess who warned of the fall of Troy, on the Colorado River and other rivers, to spell out the likely impacts of CD and helped guide states to adopt interim measures to deal with a stressed, diminishing supply.[46]

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38 Ellie I. Leydsman McGinty, *Urbanization in Utah*, *in* RANGELAND RESOURCES OF UTAH 153, 153–54 (2009), https://perma.cc/YB7S-3PLT.

39 JOSHUA ZAFFOR, COLO. FOUND. FOR WATER EDUC., MANAGING AGRICULTURE AND WATER SCARCITY IN COLORADO (AND BEYOND) 7 (2015), https://perma.cc/MX8D-U8KD.

40 *Irrigation & Water Use: Background*, U.S. DEP'T AGRIC., https://perma.cc/D77L-248P (last updated Jan. 27, 2018).

41 *See* Damian Park, *California Water Reallocation: Where'd You Get That?*, 57 NAT. RESOURCES J. 183, 185 (2017) (explaining California landowners may extract water on their land "almost without limit").

42 *See* A. Dan Tarlock, *Prior Appropriation: Rule, Principle, or Rhetoric*? 76 N.D. L. REV. 881, 893 (2000).

43 Philip Shabecoff, *After 85 Years, the Era of Big Dams Nears End*, N.Y. TIMES (Jan. 24, 1987), https://perma.cc/3SP4-HXK4.

44 *Id.* For a creative effort to recast the pre-Trump Administration Bureau of Reclamation as a more relevant player, see JEFFREY MOUNT ET AL., PUB. POLICY INST. OF CAL., IMPROVING THE FEDERAL RESPONSE TO WESTERN DROUGHT: FIVE AREAS FOR REFORM 3, 10, 14 (2016), https://perma.cc/EF7J-VPN5.

45 *About Us – Fact Sheet*, BUREAU RECLAMATION, https://perma.cc/FT6S-86KC (last updated Nov. 22, 2017).

46 The Bureau was able to develop interim shortage sharing guidelines that all three Lower Basin states ultimately accepted. *See* John Fleck, *What Seven States Can Agree to Do: Deal-Making on the Colorado River*, STAN.: RURAL WEST INITIATIVE (last modified Aug. 3, 2012), https://perma.cc/X3LH-6M85; *see also* Robison, *supra* note 2, at 542–51.

For prior appropriation, the end of dam building both strengthened and weakened it.[47] It reinforced the tendency of senior right holders to vigorously defend their rights. For example, it revived prior appropriation litigation in California.[48] In other states such as Idaho, it put pressure on the state to find ways to avoid senior calls[49] or to adopt negotiated solutions to the demand for new uses.[50] The end of the Big Dam Era has also supported modest efforts in rapidly growing states to live within a fixed water budget by tying land approvals of large new developments to the demonstration of an adequate water supply.[51]

C. Fish–White Water Rafting Power

In the 1960s, the idea that a water right could be acquired for an in situ use such as fish conservation was heresy, except to a limited extent in a few places such as Oregon.[52] An appropriative right could only be perfected by *diverting* water to a productive use.[53] Leaving water in a stream smacked of the common law doctrine of riparian rights, which the West had decisively rejected except in the two remaining dual-system states of California and Nebraska.[54] It also went against the pioneer tradition of hard work with little time for idle pursuit of recreation. In short, non-hydropower in situ uses were non-beneficial and wasteful.

Post-World War II affluence and embrace of nature by urban dwellers triggered a multi-billion dollar outdoor recreation industry,[55] and states

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47 The debate over the relevance of prior appropriation is summarized in Reed D. Benson, *Alive but Irrelevant: The Prior Appropriation Doctrine in Today's Western Water Law*, 83 U. COLO. L. REV. 675 (2012).

48 *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 316, 336–37 (Lawrence J. MacDonnell & Sarah F. Bates eds., 2010).

49 The Supreme Court of Idaho has vacillated between approving efforts to avoid senior surface water user calls against junior groundwater pumpers and honoring calls. *Compare* Am. Falls Reservoir Dist. No. 2 v. Idaho Dep't of Water Res., 154 P.3d 433, 445 (Idaho 2007) (holding that a senior water user's Delivery Call was not responded to with undue delay), *with* Clear Springs Foods, Inc. v. Spackman, 252 P.3d 71, 82 (Idaho 2011) (rejecting junior groundwater users' contention that "[i]f curtailment will result in substantial economic harm, the senior's water delivery call must be rejected" (alteration in original)).

50 *See* discussion *infra* Part V.B.

51 *See* Lincoln L. Davies, *Just a Big, "Hot Fuss"?: Assessing the Value of Connecting Suburban Sprawl, Land Use, and Water Rights Through Assured Supply Laws*, 34 ECOLOGY L.Q. 1217, 1227 (2007).

52 For a history of the state's preservation of minimum flows, see Janet Neuman et al., *Sometimes a Great Notion: Oregon's Instream Flow Experiments*, 36 ENVTL. L. 1125, 1130–31 (2006). The current statute is OR. REV. STAT. §§ 537.332–.360 (2017).

53 *See* Tarlock, *supra* note 42, at 882 & n.5, 891.

54 The legal history is set out in A. DAN TARLOCK ET AL., WATER RESOURCE MANAGEMENT: A CASEBOOK IN LAW AND PUBLIC POLICY 129–33 (7th ed. 2014).

55 Joseph Harry, *Causes of Contemporary Environmentalism*, HUMBOLDT J. SOC. REL., Fall/Winter 1974, at 3, 5. The outdoor recreation industry generates $887 billion annually in spending and sustains 7.6 million jobs nationwide. OUTDOOR INDUS. ASS'N, THE OUTDOOR RECREATION ECONOMY 2 (2017), https://perma.cc/2MNN-PWQY.

began to respond by allowing public agencies to file for minimum instream flow appropriations.[56] Leading decisions in Idaho and Montana held that a diversion was no longer necessary to provide notice to subsequent users because permit filings served the same function and the keystone element of prior appropriation was beneficial use.[57] Most instream flow rights were for high-valued sport fisheries, and this also allowed courts to find that the use was not a waste of water but a beneficial economic one.[58] States have gone further. Montana has established environmental reserves,[59] and Washington has partially set minimum stream flows which are recognized as junior appropriations.[60]

The recognition of the value of in situ uses led to a major reconception of the role of rivers. They were no longer primarily seen as accidents of nature that needed to be improved by engineering. The historic functions that natural flow regimes provided were rediscovered, and many of these functions recharacterized as ecosystem services.[61] The ultimate conclusion of this still-contested paradigm shift is dam removal and natural river restoration.[62] A myriad of state and federally funded river restoration regimes are underway, and small- and medium-sized dams have been removed.[63] This said, adaptation to the demand for in situ uses remains incomplete as the amount of water devoted to flows is relatively small

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56 For a survey of current programs, see Adell L. Amos & Christopher R. Swenson, *Evaluating Instream Flow Programs: Innovative Approaches and Persistent Challenges in the Western United States*, *in* PROCEEDINGS OF THE 61ST ANNUAL ROCKY MOUNTAIN MINERAL LAW INSTITUTE § 22.03[1] (2015).

57 *In re* Adjudication of the Existing Rights to the Use of All the Water, 55 P.3d 396, 402–03 (Mont. 2002); State Dep't of Parks v. Idaho Dep't of Water Admin., 530 P.2d 924, 929 (Idaho 1974).

58 *See, e.g.*, San Luis & Delta-Mendota Water Auth. v. United States, 672 F.3d 676, 709 (9th Cir. 2012); *In re* Adjudication of the Existing Rights to the Use of All the Water, 55 P.3d at 403; *In re* Water Use Permit Applications, 9 P.3d 409, 465 (Haw. 2000).

59 These are appropriative rights with a priority date as of the creation of the reservation. *See* MONT. CODE ANN. § 85-2-316 (2017).

60 *See* WASH. REV. CODE § 90.03.247 (2017); *see also* Lindsey Schromen-Wawrin, *Adopting Instream Flow Rules in Washington State: Can Citizens Jumpstart the Process Through the Administrative Procedure Act?*, 48 GONZ. L. REV. 561, 563–64 (2012–2013) (explaining Washington's adherence to the doctrine of prior appropriation and characterizing the state's instream flow rules as "junior," meaning that "water users whose rights were already established [prior to the instream flow rule] would not have to curtail their use").

61 *See, e.g.*, A. Dan Tarlock, *The Transformation of Water*, *in* ENVIRONMENTAL LAW AND CONTRASTING IDEAS OF NATURE: A CONSTRUCTIVIST APPROACH 248, 259 (Keith H. Hirokawa ed., 2014) (stating "[a]ll aquatic ecosystem conservation and restoration efforts now depend on a science-based, artificial predevelopment flow regime"). This thinking has worked its way into international water law. *See, e.g.*, JOSEFIN GOOCH, PROTECTING ECOLOGICAL INTEGRITY IN TRANSBOUNDARY WATERCOURSES: AN INTEGRATIONAL APPROACH TOWARDS IMPLEMENTING ENVIRONMENTAL FLOWS 18–19 (2016).

62 *See* Tarlock, *supra* note 61, at 266.

63 *See* J. Ryan Bellmore et al., *Status and Trends of Dam Removal Research in the United States*, WIREs WATER, Mar./Apr. 2017, at 1, 2 fig.1, 4–5, e1164; *see also Frequently Asked Questions About Removing Dams*, AM. RIVERS, https://perma.cc/5PGC-VJTN (last visited Jan. 27, 2018).

compared to consumptive withdrawals, and appropriations are junior to earlier rights.[64]

IV. THE IMPERATIVE, CHALLENGES, AND OPPORTUNITIES OF CLIMATE DISRUPTION ADAPTATION

The West has no choice but to adapt to CD because it is already experiencing it in the form of decreased snowpack,[65] forest pest outbreaks,[66] forest fires,[67] and sea level rise.[68] Mitigation will not help the West. Even if the targets of current international voluntary mitigation effort embodied in the 2016 Paris Agreement were to be met, compliance would be insufficient to halt projected temperature rises.[69]

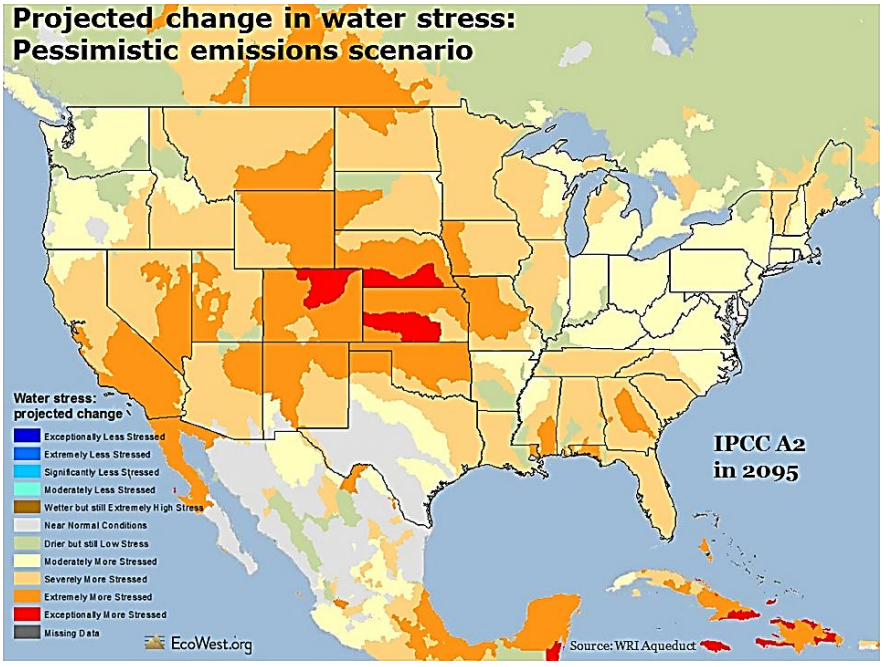

Figure 1: Projected CD-Induced Water Stress in 2095[70]

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64 *See* Amos & Swenson, *supra* note 56, § 22.04.

65 Philip W. Mote et al., *Declining Mountain Snowpack in Western North America*, 86 BULL. AM. METEOROLOGICAL SOC'Y 39, 39 (2005).

66 Barbara J. Bentz et al., *Climate Change and Bark Beetles of the Western United States and Canada: Direct and Indirect Effects*, 60 BIOSCIENCE 602, 602 (2010).

67 John T. Abatzoglou & A. Park Williams, *Impact of Anthropogenic Climate Change on Wildfire Across Western US Forests*, 113 PROC. NAT'L ACAD. SCI. U.S. 11,770, 11,773 (2016).

68 Brian A. Needelman, *Climate Change & Coastal Habitats*, *in* RESTORE-ADAPT-MITIGATE: RESPONDING TO CLIMATE CHANGE THROUGH COASTAL HABITAT RESTORATION 14, 14 (2012).

69 T. Gasser et al., *Negative Emissions Physically Needed to Keep Global Warming Below 2°C*, NATURE COMM., Aug. 3, 2015, at 1, 6, https://perma.cc/7EHP-F3BK.

70 Mitch Tobin, *An Interactive Map of Water Risk and Stress*, ECOWEST (July 23, 2013), https://perma.cc/HF9U-2CB3 (citing *Aqueduct: Water Risk Atlas*, WORLD RESOURCES INST., https://perma.cc/VJA2-CXLR (last visited Jan. 27, 2018)).

A. What Can We Expect and Will It All Be Bad?

Adaptation will be a challenge because impacts remain difficult to predict, unevenly distributed across the region, and there are no simple baselines for adaptation targets. To develop a coherent adaptation strategy, we need to have reasonable CD-adjusted water supply projections. We are not there yet, in part, because what we once thought was a bedrock assumption keeps changing. Until mid-2017, the working assumption was that the West would, with some regional variation, be wetter and warmer and have less net available water.[71] More rain and less snow means more winter runoff and evaporation,[72] resulting in less net water for cities, farms, fish, and hydroelectric energy.[73]

This scenario seems to be holding for the five "hard core" arid states. Arizona, Colorado, Nevada, New Mexico, and Utah are already experiencing higher temperatures than any comparable period in at least 600 years.[74] Projected annual average temperature increases in 2041–2070 range from 2.5°F to 5.5°F and from 5.5°F to 9.5°F in 2070–2099.[75] In addition to less available water, reduced snowpack will impact the ski industry, as it already has in Europe.[76] Forest fires will increase in frequency and intensity.[77] Forests will also experience more extensive tree deaths, and warmer, ash-laden rivers will impact fishing and rafting.[78]

For California users dependent on the Colorado River, all studies predict a decrease in the average flow as demand increases, although estimates vary widely. A 2011–2012 Bureau of Reclamation study mandated by Congress put the figure at 8.7%.[79] In 2017, two respected climate scientists

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71 The Bureau of Reclamation reports under the SECURE Water Act reflect this consensus. 42 U.S.C. § 10363 (2012); *see* BUREAU OF RECLAMATION, SECURE WATER ACT SECTION 9503(C)—RECLAMATION CLIMATE CHANGE AND WATER 2016, at 4-5 to 4-6 (2016), https://perma.cc/SZ8S-4GPW.

72 *See* T.P. Barnett et al., *Potential Impacts of a Warming Climate on Water Availability in Snow-Dominated Regions*, 438 NATURE 303, 303, 306 (2005).

73 *See* Benjamin K. Sovacool, *Running on Empty: The Electricity-Water Nexus and the U.S. Electric Utility Sector*, 30 ENERGY L.J. 11, 26 (2009); Dominik Wisser et al., *Beyond Peak Reservoir Storage? A Global Estimate of Declining Water Storage Capacity in Large Reservoirs*, 49 WATER RESOURCES RES. 5732, 5738 (2013).

74 Gregg Garfin et al., *Chapter 20: Southwest*, *in* CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL ASSESSMENT 462, 464 (2014), https://perma.cc/F78E-6EBW.

75 *Id.*

76 *See, e.g.*, Robert Steiger & Johann Stötter, *Climate Change Impact Assessment of Ski Tourism in Tyrol*, 15 TOURISM GEOGRAPHIES 577, 579–80 (2013) (discussing whether increased snow making can compensate for expected winter snow loss in the 21st century).

77 OFFICE OF THE PRESIDENT, CLIMATE CHANGE: THE FISCAL RISKS FACING THE FEDERAL GOVERNMENT: A PRELIMINARY ASSESSMENT 25 (2016) ("[B]oth fire and climate are expected to substantially change vegetation composition over the coming 85 years, including the prevalence of vegetative fuels that enable and sustain fires.").

78 *See, e.g.*, ROBERT REPETTO, DEMOS, NEW MEXICO'S RISING ECONOMIC RISKS FROM CLIMATE CHANGE 4 (2012) (explaining the probable impact of climate change on New Mexico's tourism industry).

79 BUREAU OF RECLAMATION, COLORADO RIVER BASIN WATER SUPPLY AND DEMAND STUDY: TECHNICAL REPORT B – WATER SUPPLY ASSESSMENT, at B-85 tbl.B-2 (2012).

concluded that "warming could reduce water flow in the Colorado by 20 percent or more below the 20th-century average by midcentury, and by as much as 40 percent by the end of the century."[80] The situation for the rest of the state has become more complicated. New studies predict that northern and central California may see more frequent rain events during the winter with a net increase in precipitation.[81]

To further complicate scenario development, CD is often presented as an endless series of adverse land and water impacts,[82] but there will be winners as well as losers. The blessed Pacific Northwest is in the winner's circle, but it will not completely escape the impacts of CD.[83]

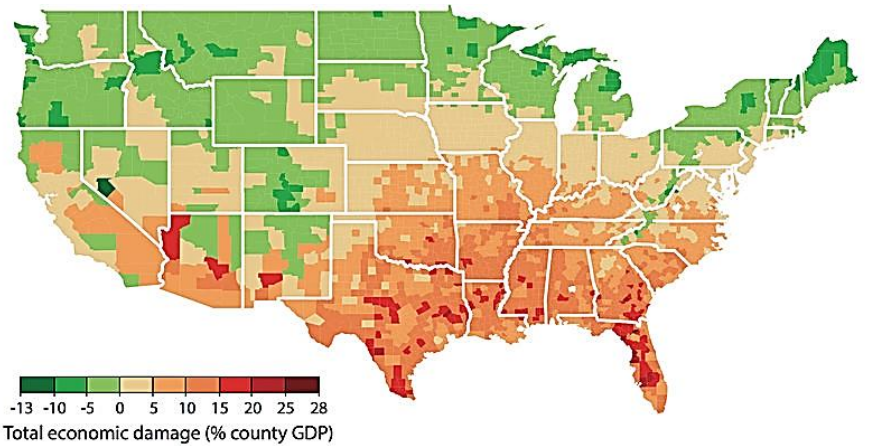

Figure 2: Projected Economic Impact of CD[84]

As irrigated agriculture in California and elsewhere faces more intense competition for water stresses such as diminished surface and groundwater supplies,[85] crop production may shift northward. The wine industry is a case in point: Oregon and Washington state may be winners.[86] Within the region, wine grape production is already shifting north in northern Washington state

80 Brad Udall & Johnathan Overpeck, *Climate Change Is Shrinking the Colorado River*, CONVERSATION (June 13, 2017), https://perma.cc/3R4Q-SQZD.

81 Xiang Gao et al., *Twenty-First-Century Changes in U.S. Regional Heavy Precipitation Frequency Based on Resolved Atmospheric Patterns*, 30 J. CLIMATE 2501, 2518–19 (2017).

82 *See, e.g.*, Garfin et al., *supra* note 74, at 464 (summarizing a long series of adverse outcomes with climate change projections).

83 *See* Solomon Hsiang et al., *Estimating Economic Damage from Climate Change in the United States*, 356 SCIENCE 1362, 1364 (2017).

84 Christopher Joyce, *Mapping the Potential Economic Effects of Climate Change*, NAT'L PUB. RADIO (June 29, 2017), https://perma.cc/U9HV-WRM5.

85 BUREAU OF RECLAMATION, *supra* note 79, at B-87 tbl.B-3; Udall & Overpeck, *supra* note 80.

86 *See* Lee Hannah et al., *Climate Change, Wine, and Conservation*, 110 PROC. NAT'L ACAD. SCI. U.S. 6907, 6909–10 (2013) (examining the expected increase of grape production in select areas of the Pacific Northwest).

and Canada.[87] California vineyards will require considerably more water to survive temperature increases.[88] But, modest temperature rises in the Willamette Valley could make its sensational Pinot Noirs even better, although the risks of more extreme climate events could temper this optimism.[89]

B. The Emerging Global "Consensus" Adaptation Framework

There is an emerging consensus that water policy should pursue two not completely consistent goals complicated by CD. The first is that all nations and sub-regions should enjoy water security.[90] Water security has three linked goals: 1) access to sufficient water to support human well-being, economic development and political stability; 2) the conservation of aquatic ecosystems; and 3) the sustainable management of the risks of CD.[91] The second is that CD requires we manage ecosystems and their valuable services[92] for resilience. Resilience is defined "as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to retain essentially the same function, structure, identity, and feedbacks."[93] The problem, as the next Subpart discusses, is that it is difficult to derive baselines to measure resilience, and efforts to use backward-looking ones may be self-defeating.

C. No Baselines

Adaptation needs a baseline against which success can be measured, but we cannot rely on the past. The three major transitions that began in the late 1960s were aided by the illusion that there was a baseline to measure adaptation: nature unsullied by human intervention and in perpetual balance. The underlying ethical assumption was "that the natural world is not just to be exploited but to be both savored and protected."[94] Thus, much of the remaining unexploited landscape and flowing rivers should be walled off to the maximum extent possible from intensive human use. This was

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87 *Id.*

88 *Id.* at 6907.

89 Becca Yeamans-Irwin, *The Effect of Climate Change on the Washington and Oregon Wine Industries – My Latest Contribution to SOMM Journal*, ACAD. WINO (Aug. 13, 2015), https://perma.cc/SXE4-LNQ4.

90 *See, e.g.*, EELCO VAN BEEK & WOUTER LINCKLAEN ARRIENS, GLOB. WATER P'SHIP, WATER SECURITY: PUTTING THE CONCEPT INTO PRACTICE 12–13 (2014).

91 *Id.*

92 *See* Robert Costanza et al., *Changes in the Global Value of Ecosystem Services*, 26 GLOBAL ENVTL. CHANGE 152, 155–56 & tbl.3 (2014) (putting the figure for the aggregate annual value of services at $145 trillion); *see also* Robert Costanza et al., *Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go?*, 28 ECOSYSTEM SERVS. 1, 3 (2017).

93 Carl Folke et al., *Regime Shifts, Resilience, and Biodiversity in Ecosystem Management*, 35 ANN. REV. ECOLOGY EVOLUTION & SYSTEMATICS 557, 558 (2004).

94 ROBERT WYSS, THE MAN WHO BUILT THE SIERRA CLUB: A LIFE OF DAVID BROWER 292 (2016).

supported by theories of ecology which posited that ecosystems reached a natural stasis if protected from human degradation.[95] These assumptions no longer hold, and thus, adaptation strategies are not a reliable guide to the future.

The illusion of the balance of nature was the first to go. Nature is but a construct, and what we think of natural has long been influenced by human intervention.[96] In the 1990s, the equilibrium paradigm was deconstructed and replaced with a complex, stochastic non-equilibrium one. In his path-breaking book, *Discordant Harmonies*, Professor Daniel Botkin characterized the equilibrium paradigm as a misguided effort to match science to theological and scientific visions of a perfect universe.[97] His basic conclusion was that there is no ideal state of nature.[98] Thus, at best, ecosystems can be managed rather than restored or preserved, and management will be a series of calculated risky experiments: "nature moves and changes and involves risks and uncertainties and . . . our own judgments of our own actions must be made against this moving image."[99]

For water, as Houston discovered in 2017 after the third 500-year flood in three years, hydrological predictions are less bounded than previously assumed.[100] For decades, the science of hydrology assumed that river flows,

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95 The ur-text is Aldo Leopold's synthesis of his ecologically based land ethic. "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." ALDO LEOPOLD, SAND COUNTY ALMANAC AND SKETCHES HERE AND THERE 224–25 (1949). CURT MEINE, ALDO LEOPOLD: HIS LIFE AND WORK (1988) traces the evolution of Leopold's thinking based on his conservation experiences. Leopold was read to provide an ecological justification for the land ethic in the equilibrium paradigm in ecology, or, as it was crudely and popularly expressed: "the balance of nature." A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121, 1122 (1994). "Legislators and lawyers enthusiastically embraced this paradigm because it seemed to be a neutral universal organizing principle potentially applicable to the use and management of all natural resources." *Id.* The contributions of modern environmental resource management to the legal system, the National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321–4370h (2012), the Endangered Species Act of 1973, 16 U.S.C. §§ 1531–1544 (2012), the Wilderness Act of 1964, 16 U.S.C. §§ 1131–1136, and parts of the Clean Water Act such as section 404, 33 U.S.C. § 1344 (2012), are premised on this paradigm. Tarlock, *supra*, at 1122–23.

96 *See* A. Dan Tarlock, *Slouching Toward Eden: The Eco-Pragmatic Challenges to Ecosystem Revival*, 87 MINN. L. REV. 1173, 1174 (2003).

97 *See generally* DANIEL B. BOTKIN, DISCORDANT HARMONIES: A NEW ECOLOGY FOR THE TWENTY-FIRST CENTURY (1990).

98 *Id.* at 189–90. The philosophical basis for the new ecology can be found in Bill McKibben's widely read *The End of Nature*, which argues the modern mind separates humanity from nature and thus the romantic visions of harmony between humanity and nature are impossible. BILL MCKIBBEN, THE END OF NATURE 8 (1989). However, Justice Oliver Wendell Holmes, dissenting in *Abrams v. United States*, articulated the central message of the non-equilibrium paradigm; in defense of his "market of ideas" theory of the First Amendment, he wrote: "[o]ur Constitution . . . is an experiment, as all life is an experiment." 250 U.S. 616, 630 (1919) (Holmes, J., dissenting).

99 BOTKIN, *supra* note 97, at 190.

100 *See* Laura Parker, *After Harvey, Are Epic Rains the New Normal?*, NAT'L GEOGRAPHIC (Sept. 1, 2017), https://perma.cc/GC7K-WG2R.

within predictable variations, were basically constant over time.[101] But, the idea of stationarity has been replaced by CD-driven non-stationarity, where the past does not predict the future.[102] And, it gets more complicated. The current era of human-flora and fauna interaction has been labeled the Anthropocene.[103] The dominant characteristic of this new era is not gradual change in the earth, but the rapid change caused by human intervention which shows no signs of abating.[104]

The basic lesson that one can draw from is that we cannot simply look backwards.[105] In addition to the non-stationary problem, two additional examples suffice. First, ecosystem management is premised on the distinction between native and exotic species,[106] and the distinction is embedded in law.[107] For example, we are spending millions to keep Asian Carp from entering the Great Lakes,[108] and Oregon is aggressively trying to

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101 *See* Robin Kundis Craig, "*Stationarity is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 15 (2010) ("[A] group of researchers noted . . . that current water resource management in the developed world is grounded in the concept of stationarity—'the idea that natural systems fluctuate within an unchanging envelope of variety.'"); *cf.* Bruce Babbitt, *Introduction: Down the Imperiled Colorado*, 25 LAND & WATER L. REV. 1, 2 (1990) ("In 1963 [the Glen Canyon Dam was constructed] . . . [a]nd no one, not the National Park Service, the Bureau, nor the environmentalists, seriously considered what might happen twenty miles downstream . . . .").

102 *See* P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, 319 SCIENCE 573, 573 (2008) ("Stationarity is dead because substantial anthropogenic change of Earth's climate is altering the means and extremes of precipitation, evapotranspiration, and rates of discharge of rivers."). For early attempts to grapple with this increased uncertainty, see Craig, *supra* note 101, at 15–17 (arguing that, because of the extreme variation that climate change presents, environmental law should incorporate a more "flexible view of the natural world"); Robin Kundis Craig, *Climate Change, Regulatory Fragmentation, and Water Triage*, 79 U. COLO. L. REV. 825, 827 (2008) (discussing how water resource management has failed oceanic ecosystems, including a lack of foresight regarding how reduced fresh "water flow" can negatively impact the oceans).

103 The term is attributed to the Dutch chemist Paul J. Crutzen. *See* Will Steffen, Paul J. Crutzen & John R. McNeill, *The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?*, 36 AMBIO 614, 614 (2007).

104 *See id.* at 614, 620 ("Enormous, immediate challenges confront humanity over the next few decades as it attempts to pass through a bottleneck of continued population growth, excessive resource use and environmental deterioration.").

105 *See* Fernando Miralles-Wilhelm et al., *Physical Impacts of Climate Change on Water Resources* 1 (World Bank Grp., Discussion Paper, 2017), https://perma.cc/AR72-V3BX ("[C]hanges in the hydrological cycle imply that future water systems may not resemble the past (nonstationarity), so historic trends—as used in engineering designs—no longer serve as a reliable guide for assessing and managing future risks.").

106 *See, e.g.*, Martin A. Schlaepfer et al., *The Potential Conservation Value of Non-Native Species*, 25 CONSERVATION BIOLOGY 428, 430–33 (2011) (illustrating how non-native species play either an invasive or facilitative role when introduced in new ecosystems by sheltering, restoring, substituting, and augmenting conservation efforts).

107 *E.g.*, OR. REV. STAT. § 570.755 (2017) (defining "invasive species" as "nonnative organisms that cause economic or environmental harm and are capable of spreading to new areas of the state").

108 *See* Asian Carp Prevention and Control Act, 18 U.S.C. § 42(a)(1) (2012); *see also Asian Carp Response in the Midwest*, ASIAN CARP, https://perma.cc/LZ4E-SGQU (last visited Jan. 27, 2018). The Seventh Circuit has refused to order hydrological separation but has left the door open to further federal common law nuisance suits. Michigan v. U.S. Army Corps of Eng'rs, 758

prevent Asian Gypsy Moth populations from establishing themselves in the state.[109] But, there are serious arguments that some exotic species should be green-carded (at least prior to 2017) or that the distinction should be dropped all together.[110] Second, conservation biologists have complicated the distinction by arguing that CD may require the genetic modification of species should they continue to exist.[111] And, there is a strain of resilience thinking that argues that the best CD adaptation strategy is to let ecosystems degrade:

> with continued degradation caused by local stressors, altered communities become composed of disturbance-tolerant species . . . . [But] management that controls local stressors to reverse degradation and recover original species assemblages will actually increase the proportion of sensitive taxa within the assemblage, and may effectively *decrease* ecosystem resilience to climate change.[112]

D. All Previous Adaptation Assumptions Upended

CD equally undermines all three past adaptation strategies. First, it is not clear that we can continue to view irrigated agriculture as urban reservoirs. Supplies will continue to be stressed: "In many areas, streamflow and reservoir storage effects are expected to reduce water supplies for traditional peak irrigation water demands during the summer and fall growing seasons."[113] The shrinking supply is likely to intensify efforts by agriculture to adopt new strategies to hang on to existing entitlements. Agricultural interests could abandon their efforts to block the development of a coherent U.S. food and water policy in the name of food security.[114] The

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F.3d 892, 899, 905–06 (7th Cir. 2014). For a critical analysis of the court's decisions, see generally Matthew A. Kratky, Comment, *Gone Fishing: Angling for an Answer to Asian Carp Mitigation After the Seventh Circuit's Refusal to Allow Hydrological Separation*, 36 N. ILL. U. L. REV. 177 (2015).

109 OR. DEP'T OF AGRIC., GYPSY MOTH ERADICATION INFORMATION (2015), https://perma.cc/X5YU-UYFM; *see also Current Suppression and Eradication Projects*, OR. DEP'T AGRIC., https://perma.cc/9GY6-36HW (last visited Jan. 27, 2018).

110 Karrigan Börk, *Guest Species: Rethinking Our Approach to Biodiversity in the Anthropocene*, 2018 UTAH. L. REV. 169, 212–13.

111 *See, e.g.*, Anthony D. Barnosky et al., *Merging Paleobiology with Conservation Biology to Guide the Future of Terrestrial Ecosystems*, 355 SCIENCE 594, 595 (2017).

112 Isabella M. Côté & Emily S. Darling, *Rethinking Ecosystem Resilience in the Face of Climate Change*, PLOS BIOLOGY, July 2010, at 1, 3, e1000438; *see also* Barbara A. Cosens, *Legitimacy, Adaptation, and Resilience in Ecosystem Management*, 18 ECOLOGY & SOC'Y 183 (2013) (describing how a free-will management of ecosystems improves resilience to achieve sustainability goals).

113 C.D. Schaible & M.P. Aillery, *Challenges for US Irrigated Agriculture in the Face of Emerging Demands and Climate Change*, *in* COMPETITION FOR WATER RESOURCES 44, 51 (Jadwiga R. Ziolkowska & Jeffrey M. Peterson eds., 2017).

114 *See* FOOD & AGRIC. ORG. OF THE U.N & WORLD WATER COUNCIL, TOWARDS A WATER AND FOOD SECURE FUTURE: CRITICAL PERSPECTIVES FOR POLICY-MAKERS 22, 35–36, 39 (2015), https://perma.cc/A9NB-YHSJ (demonstrating a global initiative to conserve water by creating food policies that the United States has not developed).

United States currently has no coherent water or food policies,[115] which places us out-of-step with the international water community.

The international community has adopted the concept of the water-food-energy nexus, or interrelationships.[116] Nexus analysis focuses attention on the need for better water management and the use of sustainable energy to feed the world's growing population in the face of growing water demands and CD.[117] For example, European countries are beginning to develop agricultural climate change resilient strategies, but nexus thinking in the United States remains the province of nongovernmental organizations (NGOs).[118]

At this time, nexus theory is still at an abstract level.[119] But the Food and Agricultural Organization has outlined a three-step process to illuminate national policy choices: 1) the collection of evidence (data) of water use; 2) the development of different impact scenarios; and 3) response options.[120] Nexus theory can support both more and less intensive agriculture. Some water-stressed countries have applied nexus analysis to substitute virtual water (water contained in produced commodities) for scarce wet water.[121] Wet water uses a country's available supply, and virtual water substitutes imported food and commodities for national production.[122]

The wet versus virtual water choice raises the question of how a country should define its food-security goals.[123] This has substantial implications for high-producing states such as California and raises food-security concerns for the United States as a whole.[124] In the immediate

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115 *See* Disaster Assistance Act of 1988, 7 U.S.C. § 2204c (2012) (illustrating the incoherent food and water policies in place in the United States).

116 *See generally* FOOD & AGRIC. ORG. OF THE U.N., THE WATER-ENERGY-FOOD NEXUS: A NEW APPROACH IN SUPPORT OF FOOD SECURITY AND SUSTAINABLE AGRICULTURE (2014), https://perma.cc/AT5L-8W2M [hereinafter WATER-ENERGY-FOOD NEXUS].

117 *Id.* at 1–3.

118 *See, e.g.*, WATER IN THE W., WATER AND ENERGY NEXUS: A LITERATURE REVIEW 23 (2013), https://perma.cc/9GQJ-2YM9 (demonstrating a need for development in agricultural strategies); Quirin Schiermeier, *Quest for Climate-Proof Farms*, 523 NATURE 396, 396–97 (2015) (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).

119 *See* WATER-ENERGY-FOOD NEXUS, *supra* note 116, at 3 ("[T]he Water-Energy-Food Nexus has emerged as a useful concept to describe and address the complex and interrelated nature of our global resource systems . . . .").

120 *Id.* at 10–13.

121 *Virtual Water Trade*, WATER FOOTPRINT NETWORK, https://perma.cc/QYZ5-XD63 (last visited Jan. 27, 2018).

122 *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., Jan. 25, 2016, at 1, https://perma.cc/HCW9-5TXB (defining virtual water as a substitute important for socio-economic reasons).

123 *See generally* FOOD & AGRIC. ORG. OF THE U.N., TRADE REFORMS AND FOOD SECURITY: CONCEPTUALIZING THE LINKAGES 26–27 (2003), https://perma.cc/66YU-8BTQ (discussing how the definition of food security has changed over time).

124 *See* WORLD WATER COUNCIL, E-CONFERENCE SYNTHESIS: VIRTUAL WATER TRADE—CONSCIOUS CHOICES 3 (2004), https://perma.cc/W4RR-5AQ2. The author states that:

future, California water use will be potentially further stressed by nexus analysis as countries such as China, Japan, and the United Arab Emirates are already growing alfalfa in California.[125] Saudi Arabia's largest dairy owns 1,790 acres in the Palo Verde Valley along the Colorado.[126] The area was selected because landowners have an 1877 priority to Colorado River water.[127]

Nexus analysis is a double-edged sword for irrigated agriculture. A more focused water-food nexus policy could provide new ammunition to irrigated agriculture to prevent urban transfers. Conversely, the federal government could decide that certain crops are not sustainable because the water they consume is better used in alternative uses.[128] Such a policy could lead to limits on where certain crops can be provided or on federal subsidies for high water intensity crops.[129]

CD has put new dams back on the water agenda by reviving the argument that water flowing to sea is wasted and needs to be captured so more of the West's shrinking water budget can be allocated to human use.[130] This could trigger a new dam building era, although carry-over storage projects are likely to be modest and "smarter."[131] In 2014, California voters approved a $7.5 billion water bond which includes $2.7 billion for new

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> 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: OPPORTUNITIES IN A NEW ASSET CLASS 244 (2015) (describing China and Saudi Arabia's purchase of millions of acres in Africa and Asia to supply their domestic food needs); 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, 134 (2001) (describing the role scarce water resources play in national security decisions).

125 *See* Rick Mooney, *The World Wants Our Hay*, PROGRESSIVE FARMER (Feb. 2015), https://perma.cc/5LN5-X9DX (explaining other countries' use of California land to grow crops).

126 *See Saudi Arabia's Largest Dairy Company Buys Land in Palo Verde Valley for the Water Rights*, CAL. WATER NEWS DAILY (Mar. 30, 2016), https://perma.cc/P6RW-FKUQ (establishing the ownership of land in the Palo Verde Valley).

127 *Id.*

128 *See generally* M.B. PESCOD, FOOD & AGRIC. ORG. OF THE U.N., WASTEWATER TREATMENT AND USE IN AGRICULTURE (1992), https://perma.cc/J9DL-Y7EL (showing that countries restrict farmers from planting certain crops because there are better uses for water).

129 *See* Casey Clowes et al., *Thirsty for a Solution: Promoting More Efficient Water Use in the West*, 20 U. DENV. WATER L. REV. 65, 79–84 (2016).

130 *See* Denielle M. Perry & Sarah J. Praskievicz, *A New Era of Big Infrastructure? (Re)developing Water Storage in the U.S. West in the Context of Climate Change and Environmental Regulation*, 10 WATER ALTERNATIVES 437, 437–39 (2017).

131 Any new era will not replicate the go-go years between the 1930s to the 1960s but will focus on auxiliary infrastructure, such as raising the height of dams and the artificial recharge of groundwater aquifers, both proven technologies. *Id.* at 439.

storage projects.[132] New dams are an important component of Utah's strategy to support projected Wasatch Front population growth.[133] In 1991, the Utah legislature approved the Bear River Development Act,[134] and in 2016 provided initial funding for the construction of a series of dams on the main tributary to the Great Salt Lake, said to be needed to support the growing population.[135] However, in early 2017, the Utah Department of Water Resources concluded that the project should be deferred at this time due to conservation efforts and less-than-anticipated growth.[136]

CD equally puts new stresses on the modest gains in environmental flows made over the past half century.[137] We have not incorporated the concept of healthy or functioning aquatic ecosystems into most watershed budget projections.[138] In the Columbia Basin, the "[l]ower summer streamflows would exacerbate the reduced reservoir refill by increasing drafts for instream flow targets."[139] This is not good for the already imperiled spring salmon migration: "Longer migration times mean that juvenile salmon will remain in inland waterways further into the summer. This fact combined with decreasing summer flows and increasing water temperatures could also cause more salmon to die of heat stress during their migration to the ocean."[140]

V. WHAT ARE WE DOING ABOUT CLIMATE DISRUPTION AND WATER RIGHTS?

The answer to this question is "not enough," but the link between CD and water rights is slowly creeping into water planning and policy. Western states do take CD seriously, and they are trying to calculate available, future water supplies adjusted for CD and more generally how CD will impact their states.[141] But there is gap between existing planning and scenarios, and how water may have to be reallocated in the future.

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132 *Proposition 1: Water Quality, Supply, and Infrastructure Improvement Act of 2014*, LEGIS. ANALYST'S OFF. (Nov. 4, 2014), https://perma.cc/4ZQB-J5Q8; Matt Weiser, *Here's What's Happening to All That Water Bond Money*, NEWS DEEPLY (Sept. 5, 2016), https://perma.cc/VD8B-Z98V (noting that as of mid-2016, only 2% of the money had been spent).

133 *Utah Prepares for Projected Population Growth*, AM. INFRASTRUCTURE https://perma.cc/RQ8Y-KX5L (last visited Jan. 27, 2018).

134 UTAH CODE ANN. §§ 73-26-101 to 73-26-507 (West 2017).

135 Matt Weiser, *Bear River: The Biggest Dam Project You've Never Heard of*, NEWS DEEPLY (Aug. 29, 2016), https://perma.cc/QR8X-U2TW.

136 Emily Benson, *Will Utah Dam the Bear River?*, HIGH COUNTRY NEWS (Sept. 4, 2017), https://perma.cc/KKY8-99JX.

137 *See* Michael Dettinger et al., *Western Water and Climate Change*, 25 ECOLOGICAL APPLICATIONS 2069, 2070, 2078–79 (2015).

138 *See* WHITWORTH, *supra* note 7, at 45–47.

139 Jeffrey T. Payne et al., *Mitigating the Effects of Climate Change on the Water Resources of the Columbia River Basin*, 62 CLIMATIC CHANGE 233, 254 (2004).

140 JOSEPH FRIEDLAND, IMPACTS OF CLIMATE CHANGE AND CHANGING SEASONAL FLOW REGIMES ON THE COLUMBIA RIVER BASIN (2017), https://perma.cc/6Q3A-K977.

141 *See generally* CAL. ENVTL. PROT. AGENCY, CLIMATE CHANGE RESEARCH PLAN FOR CALIFORNIA (2015), https://perma.cc/459E-25PY (detailing research focuses adopted by California as a result of climate change); STATE OF OR., THE OREGON CLIMATE CHANGE

Oregon's progressive 2010 Climate Adaptation Plan and the nascent 2012 Integrated Water Resources Planning Initiative are a start but do not get to the difficult water rights questions. The Climate Adaptation Plan identified three categories of risks: very likely, likely, and more likely than not.[142] Reduced water resources were among the highest risk category: "Changes in hydrology and water supply; reduced snowpack and water availability in some basins; changes in water quality and timing of water availability."[143] It developed a series of policy options,[144] but it candidly admitted that "Oregon lacks a comprehensive water plan for extreme drought conditions."[145] Determining how water rights for irrigation will fare with changing crop needs and growing seasons under various climate change scenarios is needed.[146] Put differently, the current CD adaptation strategy is to muddle through the increasingly frequent droughts still hoping for wetter years. This may not be sustainable:

> Changes in annual hydrographs are likely to challenge water managers and users, even where annual volumes do not change. Higher flows in early spring will favor what have been junior and infrequently used storage rights, and senior rights may find less flow on the descending limb of the hydrograph through the summer and fall. In fact, the changing hydrograph will mean that some diversions thought in the 20th century to have reliable senior water rights may be without water during the hottest and driest periods of summer.[147]

Water rights holders and planners need to acknowledge that all systems of water law are risk-allocation systems. Water entitlements are inherently correlative for physical and policy reasons. CD magnifies the risks and increases the inherent uncertainty in all water rights.[148] We tend to deny this and cling to the illusion that water rights are eternal, secure property rights. CD requires that we think hard about shortage adjustment mechanisms. Security remains the keystone component of any water rights system, but we need to balance this with systems that meet the following criteria: 1) water budgets should be based on the best available CD-adjusted information; 2) entitlements should be flexible enough to adjust to

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ADAPTATION FRAMEWORK (2010), https://perma.cc/7VLP-LJ8Z [hereinafter OREGON FRAMEWORK] (describing potential consequences and responses to climate change in Oregon).

142 OREGON FRAMEWORK, *supra* note 141, at vii.

143 *Id.* at 20.

144 *See id.* at 23 ("Develop planning standards for municipal water supply based on anticipated future hydrologic conditions. Develop policies and incentives to maintain in-stream flows sufficient to support healthy fish and wildlife populations. Increase institutional capacity for water supply planning and regulation. Create a revolving fund to assist public water systems not eligible for federal capital loans and grants. Complete the water right adjudication process. Complete groundwater investigations. Conduct a statewide assessment of long-term changes to basin hydrology. Improve capacity to monitor surface water, ground water, and water use along with changes in water quality.").

145 *Id.* at 41.

146 *Id.* at 21, 41.

147 Dettinger et al., *supra* note 137, at 2074.

148 *See* discussion *supra* Part IV.

substantially changed conditions, including changes in the value of alternative uses;[149] 3) risk sharing should be reasonably efficient, and the pain of curtailments should be fairly borne by all users, consumptive and non-consumptive; and 4) water entitlements should be tradeable, subject to public policy constraints. Four non-exhaustive entitlement regimes ranging from the status quo to the semi-radical follow.[150]

A. Let Old Prior Do His Job

The case for letting prior appropriation function is that it has worked in the past and can adapt to CD. In theory, prior appropriation is a complete risk-allocation scheme.[151] The risks of curtailment are clearly assigned by time of putting water to beneficial use.[152] Thus, junior right holders should, again in theory, make an assessment of the likelihood of diminished supplies over time and adjust accordingly. Risk assessment is now easier because more state water agencies and utilities are engaging in long-term planning to assess the risks of CD.[153]

Prior appropriation does measure well for flexibility. The great strength of prior appropriation is that, despite high transaction costs, water rights are transferrable, and transfers will remain an important CD adaptation strategy for the foreseeable future.[154] Prior appropriation measures less well as an inclusive, reasonably efficient, and fair risk-sharing scheme. For example, California got through its 2014–2016 severe drought by shifting almost all the

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149 Fixed entitlements will face more stress and make adaptation more difficult. *See* U.N. ECON. COMM'N FOR EUROPE & INT'L NETWORK OF BASIN ORGS., WATER AND CLIMATE CHANGE ADAPTATION IN TRANSBOUNDARY BASINS: LESSONS LEARNED AND GOOD PRACTICES 13 (2015); Carl Bruch, *Adaptive Water Management: Strengthening Laws and Institutions to Cope with Uncertainty*, *in* WATER MANAGEMENT IN 2020 AND BEYOND 89, 100–01 (Asit K. Biswas et al. eds., 2009) (stating that adaptive management and periodic assessments create a more effective legal framework). The Supreme Court of Colorado recognized this problem in 1968 when it contrasted the constitutional protection of vested rights with the maximum utilization of water. Fellhauer v. People, 447 P.2d 986, 994 (Colo. 1968).

150 I do not, for example, consider changes such as total or partial preemption of state water law. *See* Robert W. Adler, *Climate Change and the Hegemony of State Water Law*, 29 STAN. ENVTL. L.J. 1, 4–8 (2010) (discussing why the effects of climate change could justify federal intervention of state water law systems).

151 I discussed this in more detail in Dan Tarlock, *How Well Can Water Law Adapt to the Potential Stresses of Global Climate Change*, 14 U. DENV. WATER L. REV. 1, 12–13 (2010).

152 *Id.* at 13 (explaining that in prior appropriation "[t]he risk of shortage curtailment is assigned completely to the most recent right holders, who can be required to bear the full costs of senior calls").

153 *See* Jerry Redfern, *Why Some Western Water Agencies Are Writing 100-Year Water Plans*, NEWS DEEPLY (July 25, 2017), https://perma.cc/44MK-QUER.

154 W. GOVERNORS ASS'N & W. STATES WATER COUNCIL, WATER TRANSFERS IN THE WEST: PROJECTS, TRENDS, AND LEADING PRACTICES IN VOLUNTARY WATER TRADING 18 (2012), https://perma.cc/D5VQ-XSJK (noting that "western states anticipate that water transfers will play a significant role in the allocation of water to existing and future demands. . . . This trend is reinforced by water supply uncertainty—due to climate change . . . .").

conservation duties to urban users.[155] More generally, pain is not always shared reasonably efficiently and fairly. Prior appropriation is a "tough love" regime with clear winners and losers, and this can impede physical solutions[156] that could avoid priority calls and do not substantially adversely impact senior right holders.[157]

B. Negotiate Around Old Prior

President Lyndon B. Johnson was fond of quoting Isaiah 1:18: "Come now, and let us reason together,"[158] and this aspiration has been carried over in natural resources management in the 1990s as federal and state legislatures faced increasing gridlock, and environmental protection and natural resources conservation became politicized. In the 1990s, the Clinton Administration, out of desperation, promoted negotiated settlements of many resource conflicts, and my late, much lamented friend and colleague Dean David Getches, labeled these voluntary, stakeholder-driven initiatives "outside-the-box" solutions.[159] Negotiated solutions often meet the flexibility criteria as well as inclusivity, reasonable efficiency, and fairness.[160]

The rub is that these solutions basically only work in two situations: either most stakeholders realize that alternatives such as litigation are worse or the pain of reallocation is dealt with explicitly and fairly, which usually means substantial compensation to losers. The reallocation of the Niobrara River in Nebraska is a case in point. A group of state and federal agencies and NGOs came together to reallocate prior appropriation rights held by a utility that no longer wished to operate Spencer Dam on the Niobrara River.[161] In 2016, the state legislature enacted legislation that put the last block of financing in place for a $9 million buyout of the utility's rights.[162] The early priority rights have been transferred to the state Water Resources Commission and a local Natural Resources District, and the water is now dedicated to both instream flows, including the instream flow needs of the

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155 Dan Tarlock, *California Adapts to Prolonged Drought: Any Lessons for the Humid Midwest?*, 51 VAL. U. L. REV. 519, 529–34 (2017).

156 In 1928, voters in California adopted a constitutional amendment, CAL. CONST. art. X, § 2, requiring that all water rights be used reasonably. *See* Brian E. Gray, *The Reasonable Use Doctrine in California Water Law and Policy*, *in* SUSTAINABLE WATER: CHALLENGES AND SOLUTIONS FROM CALIFORNIA 83, 84 (Allison Lassiter ed., 2015). The Amendment has been interpreted to give courts some discretion to approve adjudication decrees that satisfy existing rights by means other than the strict enforcement of them. *See* Harrison C. Dunning, *The "Physical Solution" in Western Water Law*, 57 U. COLO. L. REV. 445, 458, 463 (1986).

157 *See Am. Falls Reservoir Dist. No. 2*, 154 P.3d 433, 438–39, 444, 451 (Idaho 2007) (noting circumstances under which senior water rights holders are injured).

158 *Religion and President Johnson*, LBJ PRESIDENTIAL LIBR., https://perma.cc/R26V-QQ93 (last visited Jan. 27, 2018).

159 Getches & Tarlock, *supra* note 48, at 317.

160 *See, e.g.*, *id.* at 328.

161 *See* David Hendee, *NPPD to Shut Down Spencer Dam Hydropower Plant, Give Up Water Rights on Niobrara River*, OMAHA WORLD-HERALD (Sept. 11, 2015), https://perma.cc/E2H9-P8PX.

162 *See* Legis. B. 1038, 104th Leg. (Neb. 2016).

Wild and Scenic Rivers portion of the river and existing irrigated agriculture.[163]

C. Squeeze More Water Out of Old Prior for Newer Uses

For decades, scholars, including three prominent past and current members of Lewis & Clark, have sought to cut down older appropriative rights to free up water for newer uses, especially fish and cities. There are two competing clusters of remedies. Professors Michael Blumm and Janet Neuman have relied on judicial intervention such as the public trust[164] and the old Roman-Mormon doctrine of beneficial use to reallocate water.[165] Dean James Huffman put his faith in markets.[166] The first two doctrines will continue to play a role in water allocation, but their role in CD adaptation will not be substantial.

Beneficial use and public trust litigation and administrative proceedings do not score well on flexibility because they both require lengthy judicial and administrative proceedings to compel a reduction, as the experiences in California[167] and Hawaii[168] illustrate. Further, the public trust does not produce fair risk sharing. The doctrine hovers over the West like an avenging angel, but it is hard for users to estimate its actual impact and act accordingly. Experience teaches that the public trust works best when money follows for an out-of-box solution.[169] Beneficial use, in contrast, scores well on fair risk sharing since water users are on notice that water cannot be used wastefully. The likely future roles of these two doctrines in

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163 *See* Hendee, *supra* note 161.

164 I cite only Michael C. Blumm and Mary C. Wood in the interest of space. *See, e.g.*, MICHAEL C. BLUMM & MARY CHRISTINA WOOD, THE PUBLIC TRUST DOCTRINE IN ENVIRONMENTAL AND NATURAL RESOURCES LAW 156 (2013) ("The public trust doctrine might serve as an antidote to Western water's focus on temporal priority.").

165 *See generally* Janet C. Neuman, *Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use*, 28 ENVTL. L. 919 (1998) (exploring reforms to make beneficial use doctrine better suited for western water needs). A related doctrine imposes a reasonableness limitation on diversions. *See* A. Dan Tarlock, *The Legacy of* Schodde v. Twin Falls Land and Water Company*: The Evolving Reasonable Appropriation Principle*, 42 ENVTL. L. 37, 49 (2012) (explaining that the reasonable appropriation doctrine through *Schodde* determines the reasonableness of one use in relation to other uses).

166 *See* James L. Huffman, *Trusting the Public Interest to Judges: A Comment on the Public Trust Writings of Professors Sax, Wilkinson, Dunning and Johnson*, 63 DENV. U. L. REV. 565, 584 (1986) (arguing to improve the private rights system rather than relying on public trust).

167 *See* Nat'l Audubon Soc'y v. Superior Court, 658 P.2d 709, 712 (Cal. 1983) (resulting in the reduction of diversions from tributaries to Mono Lake only after the California legislature appropriated $60 million to enable Los Angeles to acquire alternative supplies); *see also* Leigh A. Jewell & Craig Anthony (Tony) Arnold, *The Real Public Trust Doctrine: The Aftermath of the Mono Lake Case*, *in* BEYOND LITIGATION: CASE STUDIES IN WATER RIGHTS DISPUTES 155, 179–80 (Craig Anthony (Tony) Arnold & Leigh A. Jewell eds., 2002).

168 *See In re* Water Use Permit Applications, 9 P.3d 409, 422–25 (Haw. 2000) (detailing the lengthy procedural history and noting that the "appeal arises from an extended dispute").

169 *See* Robin Kundis Craig, *Adapting to Climate Change: The Potential Role of State Common-Law Public Trust Doctrines*, 34 VT. L. REV. 781, 806–07 (2010) (offering such solutions).

CD adaptation will be to reinforce state regulation that imposes tighter conservation standards on water-use or water-sharing reforms.[170] In the end, as discussed in Part VI, markets may be more effective in reallocating water, at least within the agricultural sector.

D. Blow Up Old Prior: The Australian Solution, Volumetric Rather than Fixed Entitlements

In the late 19th century, Australia invited U.S. water experts to advise them on the drafting legislation to support its growing irrigation economy.[171] But, after studying the doctrine of prior appropriation, New South Wales opted for a licensing system that did not include priority.[172] However, the licensing system had to be reformed when the Australian states decided to promote water marketing.[173] A hybrid of grandfathered volumetric entitlements and curtailment preferences emerged.[174] 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.[175]

As CD kicks in, there is much to recommend a system that both provides a relatively high degree of security for water users but also puts all users on notice that the pain of shortages will be shared by all users. Leaving aside political resistance, the constitutional challenges are formidable. State courts approved the transition from common law riparian rights to prior appropriation based on the theory that actual users were better off when their rights were converted to more secure appropriative ones and non-users had low expectations of being able to assert future rights.[176] Existing appropriators will argue that the Fifth Amendment prohibits a state from moving from secure to non-secure rights.[177] The counter argument is that the state can adopt a system of entitlements necessary to adapt to CD with

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170 *See* Light v. State Water Res. Control Bd., 173 Cal. Rptr. 3d 200, 205–06 (Cal. Ct. App. 2014) (upholding restrictions in frost prevention irrigation by wine growers in the Napa region because, under the California constitution, water right holders must use water in a reasonable and beneficial manner).

171 *Global History of Irrigation, Irrigation Timeline and History of Irrigation in Australia*, IRRIGATION AUSTL., https://perma.cc/U4X6-ZTYT (last visited Jan. 27, 2018).

172 KATE STOECKEL ET AL., AUSTRALIAN WATER LAW 3, 84 (2011).

173 *Id.* at 84.

174 *See id.*

175 *See* MICHAEL YOUNG ET AL., DUKE NICHOLAS INST. FOR ENVTL. POL'Y SOLS., UNBUNDLING WATER RIGHTS: A BLUEPRINT FOR DEVELOPMENT OF ROBUST WATER ALLOCATION SYSTEMS IN THE WESTERN UNITED STATES 15–16 (2015), https://perma.cc/R2CW-ER77 (describing the formula used in the model share system).

176 *See* Benson, *supra* note 47, at 676–77, 680.

177 *See* Paul G. Taggart, *Addressing Water Shortages with Prior Appropriation Principles*, 24 NEV. LAW. (State Bar of Nev.), July 2016, at 20, 20–21, 24 (criticizing plan to adopt the Australian model for groundwater basins). However, Young recommends that new entitlements would reflect the priority of use. *See* YOUNG ET AL., *supra* note 175, at 5, 11, 15.

alternative financial security under its traditional police power over common property resources.[178]

VI. CONCLUSION

Where does this leave us in trying to plan for the future? For the foreseeable future, prior appropriation will remain as the framework for CD adaptation. But, it will be less our grandparents and parents law. It will be supplemented by market pressures combined with increasingly innovative out-of-the-box solutions, and it will push agriculture to consider alternative cropping patterns, less intensive uses, and new sharing patterns.[179] The fate of Pima cotton acreage in California's San Joaquin Valley illustrates the harsh discipline that the market imposes during a prolonged drought.[180] California Pima cotton is in demand for high-quality cotton products, especially polo shirts, but there is a world cotton glut, driven in part by the shift to high-performance synthetic fabrics from locker rooms to our living rooms.[181] As a result, California cotton acreage fell from nearly 306,000 acres in 2011 to around 100,000 acres in 2015, despite farmer shifts from flood to drip irrigation.[182] Western acreage fluctuates yearly, but the trend is away from cotton.[183]

These changes will occur watershed by watershed. Organizations such as the Freshwater Trust are using state-of-the art technology to match needed river flow conditions with targeted crop shifts and water right purchases with minimal disruption (and sometimes of improvement) of the

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178 Western states claim "ownership" of water is trust for the public, but this is a fiction. State power to control the use of water is regulatory, not proprietary. *See, e.g.*, State v. Superior Court, 93 Cal. Rptr. 2d 276, 285, 288–89 (Cal. Ct. App. 2000) (holding that the insurer cannot invoke the "owned property" exclusion to avoid indemnification of the state for Superfund liability). The best articulation of the relationship between "ownership in trust" and the police power remains Frank J. Trelease, *Government Ownership and Trusteeship of Water*, 45 CALIF. L. REV. 638 (1957).

179 The Upper Klamath Basin Comprehensive Agreement is a model, although the complete basin settlement has not been implemented due to lack of federal legislation and funding. UPPER KLAMATH BASIN COMPREHENSIVE AGREEMENT (2014), https://perma.cc/UJ3T-K3W2; *see* Holly Dillemuth, *Tribes Call for Agreement Termination*, HERALD & NEWS (May 18, 2017), https://perma.cc/QY6Y-WMKM.

180 *See* Hiroko Tabuchi, *A Once-Flourishing Pima Cotton Industry Withers in an Arid California*, N.Y. TIMES (Aug. 7, 2015), https://perma.cc/C49V-YLFT.

181 *See* Julie Wernau, *Global Glut Crops Up in Cotton*, WALL STREET J. (June 9, 2015), https://perma.cc/WF6X-CDGT (discussing the different uses of cotton).

182 Tabuchi, *supra* note 180.

183 Todd Fitchette, *Estimate: California Cotton Acreage Drops 24 Percent*, WESTERN FARM PRESS (June 2, 2015), https://perma.cc/6D3G-B6ZH ("California cotton acreage totaled more than one million from about 1973 through 1997. Since then acreage numbers have dropped significantly each year."). *But see* Ron Smith, *10 Percent More Cotton Acres in 2017?*, DELTA FARM PRESS (Feb. 11, 2017), https://perma.cc/8Y69-3DSP ("Far West producers are expecting to plant 268,000 upland cotton acres – a 15.1 percent increase from 2016. Arizona is responsible for the large increase, with California acreage down slightly and New Mexico acreage up slightly.").

existing watershed economy.[184] This could help move us to the more sustainable use of water in line with John Wesley Powell's vision of a western landscape in harmony with which the harsh and changing climate natures endows it.

184 *See* WHITWORTH, *supra* note 7, at 87–88.