Today's Crutch, Tomorrow's Calamity: Interstate Aquifer Management Must Center Sustainable Yield

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The United States lacks any meaningful interstate groundwater regulation. Without regulation, users of groundwater will continue to deplete precious aquifers. As aquifers get further depleted, overall water security diminishes, overuse becomes more entrenched, and the adverse effects from overuse become increasingly dangerous. Climate change induced drought and the over appropriation of surface waters will intensify interstate groundwater disputes going forward. The Supreme Court recently considered one of these conflicts in Mississippi v. Tennessee. *The Court held that its doctrine of equitable apportionment applied to interstate groundwater disputes. Previously, the Court had only applied equitable apportionment to interstate surface waters and border-crossing anadromous fish. The Court ultimately dismissed the case on procedural grounds, leaving open how it would equitably apportion groundwater.*

This Note demonstrates that the Court's surface water equitable apportionment doctrine, which primarily protects established uses, is insufficient to protect interstate groundwater resources. Protecting established uses of an overused aquifer ensures further depletion. Instead of relying on its surface water doctrine, the Court should create a new equitable apportionment doctrine for groundwater that uses proportional sustainable yield as its guiding beacon. Proportional sustainable yield allows each state to use the amount of groundwater that it contributes to the aquifer each year.

In addition, Congress and federal agencies should step in to incentivize interstate groundwater compacts by offering to fund groundwater-related projects, but only after the relevant states successfully negotiate a sustainable groundwater compact. Since the problem of aquifer depletion becomes more

DOI: https://doi.org/10.15779/z380283

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insidious with each passing year, prompt action must be taken to bring groundwater use into balance with the rate of aquifer recharge.

INTRODUCTION

Cape Town, South Africa has more people than any U.S. city other than New York.[1] During a multi-year drought, the reservoirs feeding Cape Town dried up. The city limited residents to using just thirteen gallons of water a day,

1. *Population and Demographic Trends: Cape Town, South Africa*, ARC GIS STORY MAPS, https://storymaps.arcgis.com/stories/ee5b73a24e704c12b475fe0c8827dc09 (last visited May 20, 2023); William H. Frey, *2020 Census: Big Cities Grew and Became More Diverse, Especially Among Their Youth*, BROOKINGS (2021), https://www.brookings.edu/research/2020-census-big-cities-grew-and-became-more-diverse-especially-among-their-youth/.

about one-fifth the average daily New Yorker's consumption.[2] Cape Town officials set a "Day Zero" for April 12, 2018, which was just a few months away.[3] That was the date when the city would run out of water.[4] Completely. As in, turn on the tap and nothing comes out.[5] A serious idea for immediate relief read like a dystopian sci-fi novel: towing fallen Antarctic icebergs across the ocean to import emergency freshwater.[6] Luckily, the winter rains came in time to prevent Day Zero.[7] Cape Town's exclusive reliance on surface water made it particularly vulnerable to drought.[8] In response to the water crisis, Cape Town tapped nearby groundwater to make the city "more resilient to drought and other climate shocks."[9]

Groundwater is crucial to getting civilization through droughts. Policymakers must conserve aquifers as a hedge against an increasingly chaotic climate. If a city depletes its aquifer *before* getting hit with a megadrought, that city will be worse off than Cape Town in 2018. At least Cape Town had untapped aquifers to develop.

Memphis, Tennessee, in contrast to Cape Town, gets 100 percent of its municipal water from pumping the Middle Claiborne Aquifer.[10] That aquifer lies underneath eight states.[11] Memphis's extensive use of groundwater has caused billions of gallons more water to flow from Mississippi into Tennessee than would occur in natural conditions.[12] Memphis's pumping has also lowered water levels in many wells in Mississippi, making well use more expensive in the State.[13] In 2014, Mississippi sued Tennessee. This dispute recently culminated at the Supreme Court in *Mississippi v. Tennessee*, where Mississippi sought $615 million in damages from Tennessee for its alleged stealing of Mississippi groundwater.[14] This was the first time the Court heard an interstate groundwater

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2. Aryn Baken, *What It's Like to Live Through Cape Town's Massive Water Crisis*, TIME (Mar. 3, 2018), https://time.com/cape-town-south-africa-water-crisis/ (last visited May 20, 2023).
3. Amy Maxmen, *Cape Town Scientists Prepare for 'Day Zero,'* 554 NATURE 13, 13 (2018).
4. *Id.*
5. Ari Shapiro, *Cape Town Averts 'Day Zero' By Limiting Water Use*, NPR (June 28, 2018), https://www.npr.org/2018/06/28/624397903/cape-town-averts-day-zero-by-limiting-water-use.
6. Tanisha Heiberg, *Icebergs Could Float to the Rescue of Cape Town Water Crisis*, REUTERS (Apr. 30, 2018), https://www.reuters.com/article/us-safrica-drought-iceberg-idUSKBN1I11NF.
7. Ari Shapiro, *supra* note 5.
8. ORG. FOR ECON. COOP. AND DEV., WATER GOVERNANCE IN CAPE TOWN, SOUTH AFRICA 12 (2021).
9. Aron Hyman, *Cape Town Taps Into 'One of World's Biggest Aquifers' to Meet Water Needs*, SUNDAY TIMES (Aug. 6, 2020), https://www.timeslive.co.za/news/south-africa/2020-08-06-cape-town-taps-into-worlds-biggest-aquifer-to-meet-its-water-needs/.
10. *See About*, MEMPHIS LIGHT, GAS, AND WATER, https://www.mlgw.com/about (last visited May 20, 2023).
11. BRIAN R. CLARK ET AL., GROUNDWATER AVAILABILITY OF THE MISSISSIPPI EMBAYMENT 5 (2011).
12. Mississippi v. Tennessee, 595 U.S. 15, 20 (2021).
13. *See id.* at 22.
14. *See generally id*.

dispute. However, the Court didn't get to the merits of the case, instead dismissing it on procedural grounds.

Mississippi and Tennessee's groundwater war is not unique. The *Mississippi* dispute will surely be replicated by other state-line cities across America that rely heavily on groundwater. Along with Memphis, the major border cities of Jacksonville, Florida; Spokane, Washington; and Dayton, Ohio use only groundwater from interstate aquifers.[15] Three and a half million water users in southern New Jersey rely exclusively on an aquifer that reaches into neighboring New York, Pennsylvania, Delaware, and Maryland.[16] Boise, Idaho; St. George, Utah; and Las Vegas, Nevada are three rapidly growing cities that depend heavily on groundwater.[17] Conditions are ripe for the *Mississippi* dispute to replicate across the country, especially with deeper and more severe droughts in a climate-changed twenty-first century.[18]

Nearly all of the nation's principle aquifers pass interstate lines.[19] Most notably, water from the Ogallala, or High Plains Aquifer, irrigates 15 million acres in eight states, or 27 percent of the nation's irrigated land.[20] Aquifer users have caused the Ogallala to drop 300 feet in places, drying up essential rivers and wetlands in the process.[21] Another vital aquifer, the Columbia Plateau Aquifer, lies underneath Washington, Oregon, and Idaho.[22] The water it provides helps that region lead the country in ten commodity crops.[23]

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15. *Jacksonville's Drinking Water System*, JACKSONVILLE ELEC. AUTH. (2022), http://www.jea.com/about/water_supply/); Pub. Works and Utils., *Our Water*, SPOKANE CITY, https://my.spokanecity.org/publicworks/water/quality/ (last visited May 20, 2023); *Great Miami Buried Valley Aquifer*, CITY OF DAYTON, https://www.daytonohio.gov/701/Great-Miami-Buried-Valley-Aquifer (last visited May 20, 2023).

16. New Jersey Water Sci. Ctr., *Water Levels in the Ten Major Confined Aquifers of the New Jersey Coastal Plain*, USGS (2019), https://www.usgs.gov/centers/new-jersey-water-science-center/science/water-levels-ten-major-confined-aquifers-new-jersey (last visited May 20., 2023); MICHAEL BAKER INT'L, STATE OF NJ PROFILE, 4–1 (2019).

17. *Watering Idaho: Where Your Drinking Water Comes From*, BOISE STATE PUB. RADIO (Sept. 20, 2016), https://www.boisestatepublicradio.org/environment/2016-09-20/watering-idaho-where-your-drinking-water-comes-from; Jordan Verdadeiro, *How St. George's Water Department is Keeping Up With Growth*, ABC4 (Jan. 13, 2022), https://www.abc4.com/news/southern-utah/how-st-georges-water-department-is-keeping-up-with-growth/; *Where Your Water Comes From*, LAS VEGAS VALLEY WATER DIST., https://www.lvvwd.com/water-system/where-your-water-comes-from/index.html.

18. *See* Jonathan T. Overpeck & Bradley Udall, *Climate Change and the Aridification of North America*, 117 PNAS 11856, 11856–57 (2020).

19. *See* Conservation Biology Inst., *Principle Aquifers of the Conterminous United States, Hawaii, Puerto Rico, and the U.S. Virgin Islands*, DATA BASIN (2011), https://databasin.org/maps/new/#datasets=8aa5166324614020beab728536b96d97 (last visited May 20, 2023).

20. *Texas Water District Acts to Slow Depletion of the Ogallala Aquifer*, POST CARBON INST. (Feb. 13, 2012), https://www.postcarbon.org/texas-water-district-acts-to-slow-depletion-of-the-ogallala-aquifer/.

21. *See* Bridget R. Scanlon et al., *Groundwater Depletion and Sustainability of Irrigation in the US High Plains and Central Valley*, 109 PROC. NATL. ACAD. SCI. 9320, 9321 (2012).

22. Wash. Water Sci. Cent., *Columbia Plateau Groundwater Availability Study*, USGS (Jan. 3, 2011), https://www.usgs.gov/centers/washington-water-science-center/science/columbia-plateau-groundwater-availability-study.

23. *Id.*

Texas, one of the nation's largest groundwater users, shares twenty-three of its thirty aquifers with neighboring states.[24] Texas is one of the last states to follow an "absolute dominion" rule, where pumpers can essentially pump unlimited water.[25] Although Texas is not a state known for adoring regulation, Texas water regulators recognize that "[s]tates that share groundwater resources without shared management processes will experience *unknown and unquantifiable consequences* to those future groundwater resources[.]"[26] Currently, this shared management process does not exist.[27] The livelihoods of groundwater users on the other side of the Texas state line are at the mercy of Texas water users.

Some individual states have begun to take aquifer conservation seriously. Arizona passed the first major statewide groundwater law over forty years ago.[28] In 2014, California passed statewide legislation to prevent further groundwater overdraft.[29]

In contrast to existing state-level regulation, there is almost no meaningful interstate regulation of groundwater.[30] Without regulation, this invaluable resource will continue to be overused. Potential methods of interstate regulation include interstate compacts and judicial decrees. Either approach must begin with sustainable yield. Sustainable yield limits pumping to the amount of water that can be drawn from an aquifer without adverse effects.[31] Since it ensures groundwater availability into perpetuity, sustainable yield endows future generations with access to crucial aquifers.

I propose two options to divide interstate groundwaters, both of which would help set positive precedent for interstate aquifer management. First, Congress should incentivize negotiation of interstate groundwater compacts. Congress should do this by earmarking funding for managed aquifer recharge projects, groundwater treatment facilities, and water efficiency measures, and withhold that funding from states until a sustainable groundwater compact has been ratified. Second, the Supreme Court should hear an interstate groundwater case and divide the aquifer through equitable apportionment. The Court should modify the equitable apportionment test to allow each state to pump roughly the

24. TEX. WATER DEV. BD., TRANSBORDER AQUIFERS: A SUMMARY OF AQUIFER PROPERTIES, POLICIES, AND PLANNING 1 (2017).

25. *See* Joseph W. Dellapenna, *A Primer on Groundwater Law*, 49 IDAHO L. REV. 265, 274–75 (2013).

26. TEX. WATER DEV. BD., *supra* note 24, at 2 (emphasis added).

27. *Id.* at 81–82, 94, 110, 123.

28. Desmond Connall, Jr., *A History of the Arizona Groundwater Management Act*, ARIZ. ST. L. J. 313, 313 (1982).

29. *See generally* Tina Cannon Leahy, *Desperate Times Call for Sensible Measures: The Making of the California Sustainable Groundwater Management Act*, 9 GOLDEN GATE UNIV. ENVTL. L. J. 5 (2016) (detailing the passage of SGMA, California's groundwater law).

30. *See* John D. Leshy, *Interstate Groundwater Resources: The Federal Role*, 14 HASTINGS W.–NW. J. ENVTL. L. & POL'Y 1475, 1484–86 (2008).

31. *See* Frans R. P. Kalf & Donald R. Woolley, *Applicability and Methodology of Determining Sustainable Yield in Groundwater Systems*, 13 HYDROGEOLOGY J. 295, 295–297 (2005).

amount of water it contributes annually to the aquifer. Compact negotiation is preferable to judicial decree because states have better access to information, can create more flexible and creative solutions, and can ultimately make a more effective apportionment.

I. GETTING GROUNDED: GROUNDWATER BASICS

Aquifers are underground reservoirs where water occupies space between rocks and substrate.[32] Aquifers are dynamic: they constantly receive and lose water from multiple sources. Water enters an aquifer through vertical and horizontal recharge. Vertical recharge happens when water from rainfall, rivers, or lakes percolates through the soil and into the aquifer.[33] Artificial recharge is a type of vertical recharge that happens when human activities, such as irrigation runoff or intentional recharge, cause water to percolate into aquifers in ways it would not have otherwise.[34] Horizontal recharge happens when groundwater moves laterally from one basin to another.[35] In *Mississippi*, the Middle Claiborne Aquifer water naturally moved a couple inches per day from Mississippi into Tennessee, horizontally recharging Tennessee's portion of the aquifer.[36] The annual recharge of an aquifer is natural recharge plus artificial recharge.[37]

Water leaves aquifers in three ways. First, humans pump water out of aquifers. Irrigation is responsible for the lion's share of groundwater use, accounting for more than two-thirds of used groundwater.[38] Municipalities are the other substantial user, accounting for about 20 percent of all groundwater use.[39] Second, water seeps from aquifers to feed surface waters through features like springs and riverbeds.[40] Lastly, like how horizontal recharge contributes to an aquifer, horizontal discharge to other basins diminishes an aquifer.[41]

Groundwater mining, or overdraft, happens when more water exits than enters an aquifer.[42] Consistent overdraft lowers an aquifer's elevation. Overdraft has decreased aquifer elevation over 150 feet from natural levels in large areas

32. Garey A. Fox, et al., *Introduction to Groundwater Hydrology and Management*, OKLA. STATE UNIV. (May 2017), https://extension.okstate.edu/fact-sheets/introduction-to-groundwater-hydrology-and-management.html.

33. *Id.*

34. *Id.*

35. ALAN H. WELCH ET AL. EDS., WATER RESOURCES OF THE BASIN AND RANGE CARBONATE-ROCK AQUIFER SYSTEM, WHITE PINE COUNTY, NEVADA, AND ADJACENT AREAS IN NEVADA AND UTAH 70–71 (2007).

36. Mississippi v. Tennessee, 595 U.S. 15, 25 (2021).

37. Fox, *supra* note 32.

38. *See* USGS, ESTIMATED USE OF WATER IN THE UNITED STATES IN 2015, 16 (2018).

39. *See id.*

40. Darya Anderson, *The San Pedro River, Subflow, and Development*, W. LANDS, W. WATERS (Nov. 17, 2020), https://westernlandsblog.arizona.edu/san-pedro-river-subflow-and-development.

41. WELCH ET AL. EDS., *supra* note 35, at 70–71.

42. *See, e.g.*, Clark et al., *supra* note 11, at 17–25.

of the United States.[43] Groundwater mining seriously threatens the future existence of interstate aquifers.[44] Users of the Ogallala Aquifer, for example, have consumed nearly 30 percent of that aquifer.[45] If pumping continues at the current rate, that aquifer will disappear within 100 years.[46] Most regions that overlie the Ogallala Aquifer are dependent on agriculture, yet cannot sustain agriculture with rainfall alone.[47] The death of that aquifer would destroy the region's agriculture, along with the communities that depend on it.

A. The Harms of Groundwater Mining

The status quo in groundwater management, that of limited state-level management, has depleted interstate aquifers nationwide.[48] This depletion comes with far-reaching adverse effects, including direct effects on other groundwater users, indirect effects on riparian ecosystems and surface water users, saltwater contamination, and land subsidence.

First, groundwater mining has direct effects on other groundwater users. When the elevation of groundwater decreases, users must expend increasing amounts of energy, and therefore money, to pump water out of their wells.[49] If the groundwater retreats far enough, that user must drill a new, deeper well to chase the aquifer at substantial cost.[50] Even if an entire aquifer is not depleted overall, pumping can have substantial localized impacts to groundwater level. Any well creates a "cone of depression" around it, where groundwater level is lower immediately around the well, gradually tapering up to the mean groundwater level as distance from the well increases.[51] The more pumping, the larger the cone of depression. One of Mississippi's main claims in the *Mississippi* case was that Memphis' prodigious pumping near the state line caused cones of depression that extended into Mississippi.[52] These cones of depression, Mississippi argued, diminished the aquifer level in the state, making it harder for

43. *See* LEONARD F. KONIKOW, GROUNDWATER DEPLETION IN THE UNITED STATES (1900-2008) 6 (2013).

44. *See id*. at 1.

45. Richard M. Cruse et al., *Irrigation Aquifer Depletion: the Nexus Linchpin*, 6 J. OF ENV'T STUDS. & SCIS. 149, 151 (2016).

46. *Id*.; Eric L. Garner, *Factors Identifying Aquifers With a High Probability of Management Success*, 44 WATER INT'L 354, 357 (2019).

47. Warigia M. Bowman, *Dustbowl Waters: Doctrinal and Legislative Solutions to Save the Ogallala Aquifer Before Both Time and Water Run Out*, 91 UNIV. OF COLO. L. REV. 1081, 1098 (2020).

48. KONIKOW, *supra* note 43, at 6; Noah D. Hall & Benjamin L. Cavataro, *Interstate Groundwater Law in the Snake Valley: Equitable Apportionment and a New Model for Transboundary Aquifer Management*, 2013 UTAH. L. REV. 1553, 1555 (2013).

49. *See* BEVAN GRIFFITHS-SATTENSPIEL & WENDY WILSON, THE CARBON FOOTPRINT OF WATER 2 (2009).

50. *See* Scott Jasechko & Debra Perrone, *California's Central Valley Groundwater Wells Run Dry During Recent Drought*, 8 EARTH'S FUTURE, 9–10 (2020), https://onlinelibrary.wiley.com/doi/abs/10.1029/2019EF001339.

51. Well Water Program, *Groundwater and Wells*, OR. STATE UNIV., https://wellwater.oregonstate.edu/groundwater/understanding-groundwater/groundwater-and-wells (last visited May 20, 2023).

52. Mississippi v. Tennessee, 595 U.S. 15, 20 (2021).

groundwater users there to access water.[53] If a cone of depression becomes severe enough, it can even reverse the natural flow of the aquifer.[54]

Beyond harming groundwater users directly, groundwater mining can negatively impact groundwater dependent ecosystems, such as wetlands, streams, and springs.[55] Groundwater is often substantially connected to surface water.[56] In dry seasons, streams may be entirely fed by groundwater.[57] The Santa Cruz River in desert southern Arizona, for example, used to run nearly year-round.[58] Extensive groundwater pumping around the river decreased the aquifer's contribution to the river to the point that it is typically dry.[59] Though Nebraska has only depleted its groundwater by 1 percent, this has diminished the aquifer's contribution to the South Platte River by half.[60] The drying of rivers and wetlands is problematic from a conservation standpoint, because these habitats are biodiversity hotspots and important for migratory wildlife.[61] Since 100 million acres of wetlands have been destroyed in the United States, reducing impacts to existing wetlands is crucial to conserve wildlife and ecological integrity.[62] Wetlands and surface waters are also critical recreation and tourism areas, where people hunt, enjoy wildlife, boat, raft, kayak, canoe, and play.[63]

When aquifer pumping diminishes surface streams, pumpers can also deprive surface water users of their rights.[64] Groundwater mining impacts to surface water users have resulted in major litigation, such as that over the Republican River Compact between Kansas and Nebraska. Kansas sued Nebraska, claiming Nebraska's groundwater pumping violated the compact by

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53. *Id.*

54. RAYA MARINA STEPHAN ET AL., TRANSBOUNDARY AQUIFERS 172, 173 (2022).

55. Joel F. Gibson et al., *Wetland Ecogenomics – The Next Generation of Wetland Biodiversity and Functional Assessment*, WETLAND SCI. & PRACTICE 27, 27 (2015). While beyond the scope of this Note, the percolation of surface water into groundwater has led to concerning amounts of pollution of aquifers. Pesticides, oil and gas fracking fluids, and other pollutants have been found in aquifers, threatening their usability. *See* Dominic C. DiGiulio & Robert B. Jackson, *Impact to Underground Sources of Drinking Water and Domestic Wells from Production Well Stimulation and Completion Practices in the Pavillion, Wyoming, Field*, 50 ENVTL. SCI. & TECH. 4524, 4254 (2016); Laura M. Bexfield et al., *Pesticides and Pesticide Degradates in Groundwater Used for Public Supply Across the United States: Occurrence and Human-Health Context*, 55 ENV'T SCI. & TECH. 362, 362 (2021).

56. *Groundwater/Surface-Water Interaction*, USGS (Mar. 2, 2019), https://www.usgs.gov/mission-areas/water-resources/science/groundwatersurface-water-interaction.

57. M. Blumstock et al., *Baseflow Dynamics: Multi-Tracer Surveys to Assess Variable Groundwater Contributions to Montane Streams Under Low Flows*, 527 J. OF HYDROLOGY 1021, 1021 (2015).

58. Anderson, *supra* note 40.

59. *Id.*

60. Scanlon, *supra* note 21, at 9323.

61. Gibson et al., *supra* note 55, at 27.

62. *Id.*

63. *See Recreational Waters*, EPA (2017), https://www.epa.gov/report-environment/recreational-waters.

64. *See* Christine A. Klein, *Groundwater Exceptionalism: The Disconnect between Law and Science*, 71 EMORY L. J. 487, 509 (2022); Dellapenna, *supra* note 25, at 267–68.

diminishing surface water flows into Kansas.[65] An eventual settlement prohibited Nebraska from drilling new wells.[66]

Groundwater mining of coastal aquifers, such as those under Jacksonville and New Jersey, can lead to ocean saltwater intrusion. Saltwater intrusion is where saltwater percolates into aquifer space formerly occupied by freshwater.[67] The depleted aquifer sucks in ocean saltwater to replenish lost volume. Saltwater is deadly to crops and people, so saltwater intrusion can destroy aquifers even when there is still abundant freshwater within the aquifer.[68] Climate change hastens saltwater intrusion because as sea levels rise, saltwater pushes further inland.[69]

Lastly, over pumping can make areas more prone to earthquakes and subsidence.[70] In California's Central Valley, for example, over pumping has caused land in some places to sink nearly thirty feet.[71] Some parts of the Central Valley experienced subsidence of three feet in just four years.[72] This subsidence wreaks havoc on expensive infrastructure, such as the California Aqueduct that provides water to irrigators and millions of Southern Californians.[73] Subsidence due to groundwater use affects most U.S. states and has impacted over 17,000 square miles in the United States.[74]

Managing interstate aquifers at the state level is likely to result in more adverse impacts to groundwater users, depletion of surface water, saltwater intrusion, and subsidence. Preserving the status quo of interstate aquifer regulation (or lack of regulation, more precisely) is good for aquifer users in the short to medium term. But it is terrible long-term policy.

B. Sustainable Yield for Interstate Aquifers

To prevent the myriad adverse effects from over pumping, pumping from interstate aquifers should be kept to sustainable yield. In addition to mitigating adverse effects from over pumping, a policy of sustainable yield fosters water security, intergenerational equity, and interstate fairness.

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65. Kansas v. Nebraska, 574 U.S. 445, 457–58 (2015).

66. *Id.*

67. Water Res. Mission Area, *Saltwater Intrusion*, USGS (Mar. 2, 2019), https://www.usgs.gov/mission-areas/water-resources/science/saltwater-intrusion#:~:text=If%20too%20much%20freshwater%20is,contaminate%20the%20water%20supply%2C%20too.

68. *Id.*

69. *Id.*

70. Colin B. Amos et al., *Uplift and Seismicity Driven By Groundwater Depletion in Central California*, 509 NATURE 483, 484 (2014).

71. Scanlon et al., *supra* note 21, at 9323.

72. TOM G. FARR ET AL., PROGRESS REPORT: SUBSIDENCE IN THE CENTRAL VALLEY, CALIFORNIA, CAL. INST. OF TECH. 1 (2015).

73. *See id.*

74. *Land Subsidence*, USGS, https://www.usgs.gov/special-topics/water-science-school/science/land-subsidence (last visited May 23, 2023).

Sustainable yield is the amount of water users can pump without lowering the aquifer level.[75] Since pumping often diminishes surface flows before diminishing aquifer level, sustainable yield is a spectrum that encompasses different impacts to surface waters.[76] On the conservative end of the spectrum, *permissive sustainable yield* does not allow pumping to affect surface flows.[77] On the spectrum's other end, *maximum sustainable yield* allows users to pump up to the point just before the aquifer elevation begins to change, without considering impacts to surface flows.[78] The difference between permissive and maximum sustainable yield can be large.[79]

1. Sustainable Yield Is Calculatable

Calculating any type of sustainable yield requires scientists to know how much water enters and leaves the aquifer each year. Gathering this data can be complex and contains inherent uncertainties.[80] Fortunately, remote sensing and recently improved scientific models have greatly increased the accuracy of sustainable yield predictions.[81] NASA's GRACE satellites have increased scientists' ability to monitor groundwater mining by measuring changes in Earth's gravity due to pumping.[82] In 2021, hydrologists released a nationwide model that considers all aspects of the hydrological cycle, including the variables needed to calculate vertical recharge.[83] This model is high resolution, with data down to each square kilometer.[84] Higher resolution regional models better predict sustainable yield on a local scale, but they can take years and substantial investment to develop.[85]

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75. Suzanne A. Pierce et al., *Aquifer-Yield Continuum as a Guide and Typology for Science-Based Groundwater Management*, 21 HYDROGEOLOGY J. 331, 333–34 (2013).

76. *Id.*

77. *Id*.

78. *Id.*

79. *Id.* at 333.

80. Dima Al Atawneh et al., *Climate Change and its Impact on the Projected Values of Groundwater Recharge: A Review*, 601 J. OF HYDROLOGY 126602, 1 (2021).

81. Alexandra S. Richey et al., *Quantifying Renewable Groundwater Stress with GRACE*, 51 WATER RES. RSCH. 5217, 5222–23 (2015).

82. *See generally id.*; *Grace Mission*, NASA, http://www.nasa.gov/mission_pages/Grace/index.html (last visited May 23, 2023); *GRACE-FO*, NASA JET PROPULSION LAB., https://gracefo.jpl.nasa.gov/ (last visited May 23, 2023).

83. Mary M. F. O'Neill et al., *Assessment of the ParFlow–CLM CONUS 1.0 Integrated Hydrologic Model: Evaluation of Hyper-Resolution Water Balance Components Across the Contiguous United States*, 14 GEOSCI. MODEL DEV. 7223, 7227 (2021).

84. *Id.*

85. *See, e.g.*, George Kourakos et al., *Increasing Groundwater Availability and Seasonal Base Flow Through Agricultural Managed Aquifer Recharge in an Irrigated Basin*, 55 WATER RES. RSCH. 7464 (2019); CHARLES F. BRUSH ET AL., DEVELOPMENT AND CALIBRATION OF THE CALIFORNIA CENTRAL VALLEY GROUNDWATER - SURFACE WATER SIMULATION MODEL (C2VSIM), VERSION 3.02-CG 39 (2013) (describing development of the Central Valley groundwater model).

Whether users achieve sustainable yield can be verified by monitoring existing wells and using data from the GRACE satellites.[86] If the elevation of water in monitored wells does not decrease, users are within the bounds of sustainable yield.[87] Some states already have this infrastructure in place. Nebraska has over 18,000 groundwater quality monitoring wells across the state that could be used to monitor aquifer elevation.[88] The GRACE satellites can accurately and quickly determine the rate of groundwater mining from space.[89] Calculating and monitoring sustainable yield is doable with current technology and is becoming easier and more accurate as technology progresses.

Sustainable yield is not merely an academic hypothesis. As far back as 1973, Idaho's legislature and Supreme Court recognized that the Idaho Ground Water Act prohibited "pumping beyond the 'reasonably anticipated average rate of future natural recharge.'"[90] More recently, in 2014, California passed the Sustainable Groundwater Management Act (SGMA).[91] Long the nation's leader in agricultural output, California embraced the concept of sustainable yield to combat groundwater mining and improve drought resiliency.[92]

SGMA requires groundwater users to achieve sustainable yield within twenty years.[93] SGMA defines sustainable yield as the maximum amount of water that can be pumped without causing enumerated undesirable results.[94] The six undesirable results are: chronic lowering of groundwater levels, significant and unreasonable seawater intrusion, subsidence, impacts to surface waters, groundwater storage capacity, and water quality.[95] SGMA falls somewhere between permissive and maximum sustainable yield because it allows some impacts to surface waters, but not significant and unreasonable impacts.

Legislatures in both California and Idaho recognized the importance of preserving groundwater for future generations. However, both of those state's principal aquifers, the Central Valley Aquifer in California and the Snake River

86. Michelle E. Miro & James S. Famiglietti, *A Framework for Quantifying Sustainable Yield Under California's Sustainable Groundwater Management Act (SGMA)*, 5 SUSTAINABLE WATER RES. MGMT. 1165, 1168–70 (2019).

87. *Id.*

88. *See* NEB. DEP'T OF ENV'T & ENERGY, 2021 NEBRASKA GROUNDWATER QUALITY MONITORING REPORT AND CLEARINGHOUSE USERS GUIDE 6 (2021).

89. Richey et al., *supra* note 81.

90. Baker v. Ore-Ida Foods, Inc., 95 Idaho 575, 583 (1973).

91. *Sustainable Groundwater Management Act (SGMA)*, CAL DEP'T OF WATER RES., https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management (last visited May 23, 2023).

92. *See id.*; *Cash receipts by commodity State ranking*, USDA ECON. RSCH. SERV., https://data.ers.usda.gov/reports.aspx?ID=17844 (last visited May 23, 2023).

93. *See Basin Prioritization*, CAL. DEP'T OF WATER RES., https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization (last visited May 23, 2023); CAL. WATER CODE § 10727.2(b)(1) (West 2022).

94. CAL. WATER CODE § 10721(w) (West 2022).

95. *Id.* § 10721(x).

Plain Aquifer in Idaho, are intrastate.[96] The barriers to achieving sustainable yield at an interstate level are higher than the barriers that exist within a single state.[97] The biggest barriers to implementing sustainable yield for interstate aquifers are political and financial, rather than technical.

2. Sustainable Yield Promotes Fairness and Water Security

The politically easy option is to let the aquifer run out. That is a mistake that must be vigorously avoided. Sustainable yield of interstate aquifers is a much more desirable option. Sustainable yield's benefits include water security, intergenerational equity, interstate fairness, and mitigation of the adverse effects that result from overdraft.

Surface water reservoirs are notoriously unreliable in terms of water security, drying up just as users need them most. Over 73 percent of the American West was in drought as of October 2022, meaning users were desperate for water.[98] However, reservoirs were eerily low for the substantial number of users whose thirst they needed to quench. Colorado River's Lake Mead, America's largest reservoir, was only 27 percent full in the summer of 2022.[99] After twenty-two years of dropping water levels, this represents the lowest level since the reservoir was filled in the 1930s.[100] Eight of California's ten largest reservoirs were less than 35 percent full at the beginning of the 2022 water year, and the National Oceanic and Atmospheric Administration predicted that the drought would worsen throughout the season.[101] As Cape Town demonstrated, reservoirs and the rivers that feed them are not sufficient to ensure water security during drought.[102] Leaders should learn from Cape Town's water crisis and ensure a reliable water supply exists to get users through the deepest drought.

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96. While the Snake River Plain Aquifer is nearly entirely within the boundaries of Idaho, a small part of the aquifer extends into an agricultural region of eastern Oregon. KONIKOW, *supra* note 43, at 6.

97. *See, e.g.*, Hall & Cavataro, *supra* note 48 (describing failed, yearslong interstate compact negotiations of the Snake Valley Aquifer between Nevada and Utah).

98. *West, October 25, 2022*, U.S. DROUGHT MONITOR, https://droughtmonitor.unl.edu//data/png/20221025/20221025_west_trd.png (last visited May 23, 2023).

99. Michael Carlowicz, *Lake Mead Keeps Dropping*, NASA EARTH OBSERVATORY (2022), https://earthobservatory.nasa.gov/images/150111/lake-mead-keeps-dropping.

100. *Id.*

101. Granted, NOAA's predictions were wrong. A record-breaking water year replenished many of California's reservoirs and ended the drought throughout most of the state. However, this unpredicted occurrence does not rule out the possibility that future, more severe droughts *will* continue through critical winters, preventing low reservoirs from filling just as people need that water the most. *See U.S. Winter Outlook: Warmer, Drier South with Ongoing La Nina*, NOAA (Oct. 20, 2022), https://www.noaa.gov/news-release/us-winter-outlook-warmer-drier-south-with-ongoing-la-nina; *see also Current Conditions: Major Water Supply Reservoirs: 20-Aug-2023*, CAL. DEP'T OF WATER RES., https://cdec.water.ca.gov/resapp/RescondMain (last visited May 23, 2023); *California's History of Dry Spells and Recovery in Photos*, NBC LOS ANGELES (last updated Feb. 13, 2020), https://www.nbclosangeles.com/news/california-news/historic-california-drought-photos-images/28996/ (showing photos of reservoirs around the Golden State during the drought of the late 1970s).

102. ORG. FOR ECON. COOP. AND DEV., *supra* note 8 at 12.

Only sustainably managed groundwater can supply this reliability. There is twenty-five times as much groundwater on Earth as surface water.[103] Even the largest reservoirs in the United States pale in storage capacity to aquifers.[104] When groundwater is managed sustainably, it will reliably get users through long droughts by providing a large volume of water as a buffer against diminished surface resources. Managing an aquifer closer to permissive sustainable yield provides users with the most relief in non-drought years. When drought years hit, those users could increase their groundwater withdraws up to maximum sustainable yield without negatively impacting the aquifer. These groundwater withdrawals could offset meager surface water deliveries in dry years.

However, aquifers cannot provide water security during a drought if that water has already been pumped. California's 2011–2016 drought provides a potent example. California uses about one and a half times as much groundwater in drought years compared to non-drought years.[105] Models show up to 6.7 percent of all domestic wells in the Central Valley dried up during the 2011–2016 drought and its aftermath, leaving thousands of people without running water.[106] California could not drill its way out of that well crisis in time to combat the drought. Drilling deeper wells is expensive and requires substantial equipment. During this drought, well drilling cost a median of $20,000 for a domestic well and $363,000 for an agricultural well.[107] Even those who could afford drilling a new well during the drought were faced with months to years long delay because there weren't enough drillers to meet demand.[108]

Currently, the water table is dropping nearly a meter a year in many parts of California.[109] If California's water table dropped twenty meters, something that could happen in a generation or two with current use levels, 19 percent of the state's domestic and 6 percent of the state's agricultural wells would run dry.[110] The drilling infrastructure does not exist to redrill all these wells.[111]

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103. *Where is Earth's Water?*, USGS (2018), https://www.usgs.gov/special-topics/water-science-school/science/where-earths-water.

104. Lake Mead, America's largest reservoir, can hold 29 million acre-feet at full capacity. *Lake Mead*, WATER EDUC. FOUND., https://www.watereducation.org/aquapedia/lake-mead (last visited May 24, 2023). In comparison, just Oklahoma's portion of the Ogallala Aquifer holds 90 million acre-feet. *See* TEX. WATER DEV. BD., *supra* note 24, at 113. An acre-foot is the amount of water needed to cover one acre of land one foot deep.

105. CAL. DEP'T OF WATER RES., CALIFORNIA'S GROUNDWATER CONDITIONS SEMI-ANNUAL UPDATE: OCTOBER 2022 5 (2022).

106. *See* Jasechko & Perrone, *supra* note 50, at 5.

107. *Id.* at 10.

108. *See* Suzanne Goldenberg, *The Central Valley is Sinking: Drought Forces Farmers to Ponder the Abyss*, THE GUARDIAN (2015), https://www.theguardian.com/us-news/2015/nov/28/california-central-valley-sinking-farmers-deepwater-wells; Heesun Wee, *Well Water Metering? Not on My Land, Say California Landowners*, NBC NEWS (last updated May 13, 2015), https://www.nbcnews.com/storyline/california-drought/well-water-metering-not-my-land-say-california-landowners-n358296.

109. *See* CAL. DEP'T OF WATER RES., GROUNDWATER CONDITIONS REPORT WATER YEAR 2021 6–12 (2021).

110. Jasechko & Perrone, *supra* note 50, at 6.

111. Goldenberg, *supra* note 108; *see* Wee, *supra* note 108.

California's experience demonstrates that an aquifer doesn't need to be pumped out of existence for a crisis to occur. The aquifer merely needs to be near the bottom of many users' wells for catastrophe to be one drought away. Managing interstate aquifers with sustainable yield is the best way to ensure water security going forward.

Sustainable yield is fairer for future generations compared to drawing down aquifers. History proves that tension over water resources is a one-way ratchet that only tightens. For example, the Colorado River Compact, signed five generations ago, is still vigorously fought over by member states.[112] Pressure on the Colorado River is higher than it ever has been.[113] Climate change has already decreased the river's flow by 13 percent and will continue to decrease the flow further going forward.[114] Given that water tensions do not go away, the best thing this generation can hand the next is a clear framework to manage interstate groundwater disputes along with full aquifers. Sustainable yield promotes intergenerational equity because it ensures future Americans access to an essential resource that would otherwise be depleted. Their need for water in the future is no less important than our need for water now.[115]

In addition to intergenerational fairness, sustainable yield is fair between states. It ensures no state is reaping disproportionate benefits from using an interstate aquifer while putting a disproportionate amount of costs on neighboring states.[116] Users in Mississippi, for example, suffered from the large cone of depression created by Memphis' pumping. Tennessee increased the amount of water flowing across the border from Mississippi into its state by ten billion gallons per year, or enough water to supply over 90,000 American households.[117] Under the status quo, Tennessee gets rewarded for depleting its side of the aquifer because it pulls three additional gallons from Mississippi's side for every ten gallons it pumps.[118] Implementing sustainable yield would prevent states from exploiting neighboring states' part of an interstate aquifer.

Lastly, sustainable yield mitigates subsidence, impacts to surface water, and saltwater intrusion.[119] Sustainable yield is the fairest baseline for interstate aquifer management.

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112. Aydali Campa, *State Tensions Rise As Water Cuts Deepen On The Colorado River*, INSIDE CLIMATE NEWS (2022), https://insideclimatenews.org/news/17082022/colorado-river-cuts-drought/.

113. *See* Request for Input on Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions, 87 Fed. Reg. 37885 (June 24, 2022).

114. Overpeck & Udall, *supra* note 18, at 11856.

115. *See* Sigal Samuel, *Effective Altruism's Most Controversial Idea*, VOX (Sept. 6, 2022), https://www.vox.com/future-perfect/23298870/effective-altruism-longtermism-will-macaskill-future.

116. *Cf.* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

117. Mississippi v. Tennessee, 595 U.S. 15, 25 (2021); *How We Use Water*, EPA, https://www.epa.gov/watersense/how-we-use-water (last visited May 24, 2023).

118. *See Mississippi v. Tennessee*, 595 U.S. at 15, 25.

119. *See infra* Part I.A.

C. Business-As-Usual Arguments Don't Hold Water

The main opposition to sustainable groundwater management comes from farmers, associations representing farmers, and business.[120] This Subpart explores three arguments put forth by these groups against achieving groundwater sustainability.[121] First, and most compelling, achieving sustainable yield will result in widespread job loss and economic disruption. Second, increasing supply of water is a better way to deal with shortages compared to regulation of groundwater.[122] Third, decreasing agricultural output will decrease food security.[123]

1. Job Loss and Economic Disruption Requires Careful Consideration

First, when land is fallowed because of water cuts, jobs and profits will be lost.[124] In response to proposed 2022 legislation that would make it more difficult to obtain agricultural well drilling permits in furtherance of SGMA, a California assembly member claimed that "[t]he death knell of agriculture is but a few more votes like this away."[125] Implementing sustainable yield has had, and will continue to have large impacts to California agriculture. California's San Joaquin Valley (SJV) comprises the vast majority of critically over-drafted groundwater in the state.[126] To reach sustainability under SGMA, the SJV could lose up to $3.5–$7.2 billion in annual agricultural output.[127] Implementing SGMA could mean permanent fallowing over 500,000–1,000,000 acres of farmland, or 10–20 percent of the Valley's total agricultural land.[128]

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120. *AB 1739 Senate Floor Analysis*, 2014 Leg., 2013–2014 Sess. (Cal. 2014) (listing opposition groups to SGMA).

121. A major concern over groundwater management is that far-off bureaucrats and politicians do not know how to best manage a resource as nuanced and essential as groundwater. Groundwater users advocate for local control of regulation, arguing that a "one size fits all" approach ignores local expertise and introduces unnecessary bureaucracy. *See, e.g.*, Louise Lampara, *Leave Groundwater Management to Local Water Experts*, CALMATTERS (Aug. 25, 2022), http://calmatters.org/commentary/2022/08/leave-groundwater-management-in-local-water-experts-hands/. The debate of local versus centralized regulation is not a debate about whether to regulate or not, but is instead a debate about the *method* of regulation implementation. SGMA, for example, centers local control of implementation while maintaining the goal of sustainable management. *See* CAL. WATER CODE § 10723. This Note does not explore the dynamic between local and centralized control of groundwater management.

122. *See* AB 1739 Senate Floor Analysis, *supra* note 120.

123. *See Today's World is Full of Uncertainties. Your Food Supply Shouldn't be One of Them*, CAL. FARM WATER COAL., https://www.farmwater.org/farm-water-news/todays-world-is-full-of-uncertainties-your-food-supply-shouldnt-be-one-of-them/ (last visited May 24, 2023).

124. ELLEN HANAK ET AL., WATER AND THE FUTURE OF THE SAN JOAQUIN VALLEY: OVERVIEW, PUB. POL'Y INST. OF CAL. 5–6 (2019).

125. Rachel Becker, *State Lawmakers Reject Bill to Curb Farms' Water Pumping*, CALMATTERS (Sept. 2, 2022), https://calmatters.org/environment/2022/09/california-legislation-water-drought/.

126. *Critically Overdrafted Basins*, CAL. DEP'T OF WATER RES., https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins (last visited May 24, 2023).

127. HANAK ET AL., *supra* note 124, at 5–6; David Sundling & David Roland-Holst, *Blueprint Economic Impact Analysis: Phase One Results*, UNIV. OF CAL. BERKELEY, 4–5 (2020).

128. Sundling & Roland-Holst, *supra* note 127, at 3–5; HANAK ET AL., *supra* note 124, at 11.

While the economic impacts of achieving SGMA are substantial in absolute terms, they are less staggering in relative terms. Achieving SGMA in the SJV would decrease California's total annual agricultural revenue by 4–8 percent and would decrease the overall SJV regional economy by just 1–2 percent.[129] While these losses only represent the SJV, this region comprises most of the statewide losses that will happen from SGMA implementation.[130] Land fallowing is concerning, but agricultural land use is always dynamic. In 2015, for example, prior to SGMA's implementation, over 360,000 SJV acres were fallowed due to drought.[131] The impacts from land fallowing can be mitigated by other uses for the land. These uses vary from growing grains with minimal irrigation, installing solar panels, creating areas for managed aquifer recharge, and restoring the land to biodiverse desert, riparian, and wetland habitats.[132]

Zooming out, there is no doubt that bringing water use into balance with water supply will change landscapes and economies. Condemning government regulation for economic loss, though, misplaces the blame. The fact of the matter is that without increasing overall water supplies, these economic impacts will happen regardless of regulation. The only variable is when and how fast those impacts will happen. Without SGMA, economic impacts will be pushed further into the future. Farmers would spend more years over drafting the aquifer until the lack of water forces them to stop. At that point, widespread economic disruption and job loss would happen. With SGMA, jobs will be lost immediately. But SMGA also provides the SJV with a plan to remain an agricultural center in perpetuity, with a resilient aquifer to draw from in dry years. Unlike the farmer sentiment of "I'm going to pump [the aquifer] dry, and then move away," sustainable yield allows farmers to continue using otherwise 'unproductive' land for generations.[133]

While groundwater cuts will happen regardless of regulation (again, barring increased supply), the impact of decreased economic output due to SGMA will be spread unevenly across society. Achieving SGMA could cut over 21,000 SJV jobs a year.[134] Disadvantaged communities, such as farmworkers, will bear more of this job loss than other groups.[135] SGMA could decrease wages to SJV employees directly involved in agriculture by $1.1 billion each year.[136]

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129. HANAK ET AL., *supra* note 124, at 6.

130. CAL. DEP'T OF WATER RES., *supra* note 126.

131. ANDREW AYRES ET. AL, LAND TRANSITIONS AND DUST IN THE SAN JOAQUIN VALLEY, PUB. POL'Y INST. OF CAL. 14 (2022).

132. CAITLIN PETERSON ET AL., EXPLORING THE POTENTIAL FOR WATER-LIMITED AGRICULTURE IN THE SAN JOAQUIN VALLEY, PUB. POL'Y INST. OF CAL. 3 (2022); HANAK ET AL., *supra* note 124, at 11–13; Kourakos et al., *supra* note 85, at 7465–66.

133. Allison Kite, *Why an Ambitious Effort To Overhaul Kansas Water Management Fell Short*, NEB. EXAM'R (May 16, 2022), https://nebraskaexaminer.com/2022/05/16/why-an-ambitious-effort-to-overhaul-kansas-water-management-fell-short/.

134. HANAK ET AL., *supra* note 124, at 6.

135. Sundling & Roland-Holst, *supra* note 127, at 14–16.

136. *Id.* at 1–2.

Farmworkers are majority undereducated, foreign-born, low-income, and seasonal migrants or undocumented immigrants.[137] These workers are often at risk of homelessness and poverty.[138] The loss of any wages will further endanger this already at-risk group. Farm policy often turns a blind eye to farmworkers. California, for example, has failed to address the farm worker jobs that SGMA will vitiate.[139] While farm economies depend on immigrant labor, it is difficult to find political will to support these workers.[140]

Lawmakers should create policies to provide direct relief for these workers through stipends and should provide programs that transition these workers to other lines of work. Some potential jobs include renewable energy installation, habitat restoration, truck driving, and food packing and processing.[141] The impacts to farm workers are serious and must be considered whenever sustainable yield is implemented.

2. Increasing Water Supply Ignores the Main Problem

Second, opposition to groundwater management claims that policymakers should increase water supply rather than intensively regulating current use.[142] Advocates for business as usual point to desalination, long-distance water pipelines, or increased surface or subsurface storage as solutions to water shortages.[143] The California Farm Bureau says that the state's drought policy "cannot solely be a policy of managing scarcity," and that the state must increase water resources.[144] The California Chamber of Commerce, for example, believes

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137. *See Agricultural Worker Demographics*, NAT'L CTR. FOR FARMWORKER HEALTH (April 2018), http://www.ncfh.org/agricultural-worker-demographics.html.

138. *Farmworkers*, CAL. DEP'T OF HOUSING & CMTY. DEV., https://www.hcd.ca.gov/planning-and-community-development/housing-elements/building-blocks/farmworkers (last visited May 24, 2023).

139. Jesse Vad, *Valley Could See a "Mass Migration" of Farmworkers As Land Is Fallowed Under State Groundwater Law*, KVPR (May 2, 2022), https://www.kvpr.org/business-economy/2022-05-03/valley-could-see-a-mass-migration-of-farmworkers-as-land-is-fallowed-under-state-groundwater-law.

140. *See* Kamala Kelkar, *When Labor Laws Left Farm Workers Behind — and Vulnerable to Abuse*, PBS (Sept. 18, 2016), https://www.pbs.org/newshour/nation/labor-laws-left-farm-workers-behind-vulnerable-abuse.

141. Vad, *supra* note 139.

142. *See AB 1739 Senate Floor Analysis*, *supra* note 120; *Water Supply*, CAL. CHAMBER OF COM., https://advocacy.calchamber.com/policy/issues/water-supply/ (last visited May 24, 2023). *See generally* JULIAN L. SIMON, THE ULTIMATE RESOURCE 2 (2020).

143. As noted in Subpart B within Part III, increasing groundwater recharge is important. However, increasing recharge alone does not fix the fundamental issue of overdraft. Grayson Zulauf, *Desalination Will Be Key to California's Water Future. It Needs to Improve First*, CALMATTERS (Nov. 1, 2022), http://calmatters.org/commentary/2022/11/desalination-water-california-drought-climate-solution/; Kerry Jackson, *Opinion: San Diego's Successful Desal Plant Should Be a Model for California Water Policy*, TIMES OF SAN DIEGO (Mar. 4, 2021), https://timesofsandiego.com/opinion/2021/03/04/san-diegos-successful-desal-plant-should-be-a-model-for-california-water-policy/.

144. *California Farm Bureau Reacts to Initial 5% Water Allocation*, MORNING AGCLIPS (Dec. 4, 2022), https://www.morningagclips.com/california-farm-bureau-reacts-to-initial-5-water-allocation/; *Farm Bureau President Rejects Policy of Scarcity for Agriculture*, AGCLIPS (2022), https://www.morningagclips.com/farm-bureau-president-rejects-policy-of-scarcity-for-agriculture/.

desalination, increased water conveyance, and surface storage should be pursued "vigorously" over strengthening conservation measures, like SGMA.[145]

Since the ocean has effectively limitless amounts of water, advocates of desalination wish to use desalination plants to turn salty water into freshwater. San Diego has the Western Hemisphere's largest desalination plant, affectionately named "Bud."[146] Bud can distill enough saltwater for 400,000 urban residents.[147] San Diego is uniquely positioned to benefit from desalination. San Diego is a wealthy city, meaning it can afford the billion-dollar desalination facility.[148] San Diego is on the coast, meaning it does not need to pump desalinated water to far off destinations. San Diego's water prices are high since it must pipe water from Northern California and the Colorado River.[149] But even in San Diego, perhaps the city best positioned for desalination in the United States, Bud is deeply controversial due to its expense, energy, and environmental impacts.[150]

If desalination is only marginally feasible for San Diego, prospects for desalination elsewhere are dubious. Desalination infrastructure is too costly for agricultural areas, inland communities, and less wealthy cities.[151] Desalination operation is also costly, being the most energy intensive way of procuring water.[152] At a time when Americans must 'electrify everything' to meet climate change goals, adding the energy needed for large-scale desalination would make the energy transition even more difficult than it already is.[153] Technological advances will, at best, help water management at the margins.

Another way to increase supply is to build more vast water pipeline projects to pipe water in from elsewhere, or alternatively construct water storage reservoirs to hold water for times of drought. The California Aqueduct, Central

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145. *See* CalChamber, *Business Groups Identify Essential Water Supply Projects That California Should Develop*, CAL. CHAMBER OF COM. NEWS (July 28, 2022), https://advocacy.calchamber.com/2022/07/28/business-groups-identify-essential-water-supply-projects-that-california-should-develop/; Water Supply, *supra* note 142.

146. *Carlsbad Desalination Project, San Diego, California*, WATER TECH., https://www.water-technology.net/projects/carlsbaddesalination/ (last visited May 24, 2023).

147. CARLSBAD DESALINATION PLANT, https://www.carlsbaddesal.com/ (last visited May 24, 2023).

148. *See* Jackson, *supra* note 143.

149. *See Imported Water Supplies*, SAN DIEGO CNTY. WATER AUTH., https://www.sdcwa.org/your-water/imported-water-supplies/ (last visited May 24, 2023).

150. George Courser, *The REAL Truth Behind Carlsbad "Bud" Lewis Poseidon Desalination Plant. A Costly Mistake.*, SIERRA CLUB ANGELES CHAPTER (Mar. 7, 2022), https://angeles.sierraclub.org/news_conservation/blog/2022/03/the_real_truth_behind_carlsbad_bud_lewis_poseidon_desalination_plant.

151. Joyner Eke et al., *The Global Status of Desalination: An Assessment of Current Desalination Technologies, Plants and Capacity*, 495 DESALINATION 1, 5 (2020).

152. Desalination is even more energy intensive than the California Aqueduct, which pumps water hundreds of miles and over mountains. *See* HEATHER COOLEY & MATTHEW HEBERGER, KEY ISSUES FOR SEAWATER DESALINATION IN CALIFORNIA 7 (2013).

153. *See We Need to Make 'Electrifying Everything' Easier*, SCI. AM. (July 1, 2022), https://www.scientificamerican.com/article/we-need-to-make-electrifying-everything-easier/.

Arizona Project, Hoover Dam, and Glen Canyon Dam are classic twentieth-century examples of increasing supply. Politicians see water pipeline projects, as opposed to groundwater regulation, as the solution to increased water demand in arid places like Arizona.[154] If only water from the Great Lakes could be pumped into the Colorado River. Or water from the wet Pacific Northwest down to drought-prone California.

But no state wants to give up its water, especially in an increasingly unpredictable climate. In the 2000s, the eight Great Lakes states set aside their differences to negotiate the Great Lakes Compact *specifically* to prevent water exports to the southwest.[155] Beyond political infeasibility, the water from interstate water piping projects would be too expensive for agricultural use due to infrastructure and energy costs.[156] Lastly, laws such as the National Environmental Policy Act and the Clean Water Act, which were enacted after the big twentieth-century water projects, create new barriers for such projects.[157] The massive water piping and storage projects of the twentieth century will, in all likelihood, not be replicated.

Increasing supply is not an effective method of decreasing water use. Instead, increasing supply leads to increased overall consumption, which tends to entrench water deficits rather than fix them. In his book on California water history, *The Dreamt Land*, journalist Mark Arax speaks with a vineyardist on how this trend happened in California:

> "We spread the resource of water farther and farther out until we became hooked on a deficit model." . . . Every time the farmers were about to confront the hard truth of scarcity . . . society bailed them out. When crops grew beyond the capacity of our rivers, the government wouldn't tell them, "No more." Instead of letting farmers suffer the consequences of their overreach, the government came to the rescue. It stole them not one river but two . . . . The growers then did what growers are fixed to do: They kept expanding . . . . "The farmer cried wolf and got himself a new river and a couple of dams," [the vineyardist] says. "When he went dry again, he figured, 'Why not cry wolf a second time?' He got himself a new project and an aqueduct. We bought some time. We saved ourselves for thirty or forty years. In that window, we doubled down again. We grew and grew, and now we're right back where we started, crying wolf again."[158]

154. Tony Davis, *Once Again, Arizona Hopes to Import Out-of-State Water in Face of Crisis*, TUCSON (May 29, 2021), https://tucson.com/news/local/once-again-arizona-hopes-to-import-out-of-state-water-in-face-of-crisis/article_c47bf80a-be39-11eb-918b-13b88dd52f2f.html.

155. *See The Great Lakes Compact*, FOR LOVE OF WATER, https://forloveofwater.org/great-lakes-compact/ (last visited Nov. 11, 2022); *The Great Lakes Compact*, ALLIANCE FOR THE GREAT LAKES, https://greatlakes.org/campaigns/defending-the-great-lakes-compact/ (last visited May 25, 2023) (explaining that all eight compact states voted to allow limited water export to a nearby, but out of basin, town in Wisconsin as long as that water was eventually returned to the Great Lakes).

156. *See* Davis, *supra* note 154.

157. 42 U.S.C. § 4321; 33 U.S.C. § 1341.

158. MARK ARAX, THE DREAMT LAND 505–06 (2019).

Increasing supply is not a strategy to mitigate groundwater overdraft. It is a strategy to increase agricultural output and stretch an unsustainable system as far as it can go. Building more reservoirs or piping water from elsewhere does not fix the fundamental issue of overuse.

3. Implementing Sustainable Yield Will Not Endanger Food Security

The last argument for business as usual is that farmers must continue pumping groundwater to meet the nation's agricultural needs.[159] In 2022, the California Farm Water Coalition ran a full-page ad in the *Wall Street Journal*. It read, "[T]oday's policies governing the use of water are out of balance, putting our food supply at risk. We can fix this NOW by utilizing existing water infrastructure and restoring balance to government water policy. When grocery shelves are empty, it will be too late."[160] As mentioned above, implementing sustainable yield would require reducing the number of acres under cultivation.[161] A study found that managing all U.S. cropland with sustainable yield, under the "most pessimistic scenario," would decrease corn and soy production on irrigated land by 45 percent and 37 percent, respectively.[162] Critics of groundwater regulation say this reduction of food leads to food insecurity.[163]

It might, but that is a choice policy makers have. Limiting aquifer use to sustainable yield does not need to decrease food security. While those percentages seem high, irrigated corn and soy acreage is between 11–13 percent of total corn and soy acreage planted in the United States. This means that total reductions of those crops would be substantially less than the reductions that would need to occur solely on irrigated lands.[164] Far more than that amount of agricultural production is used to inefficiently feed animals instead of people.[165]

159. *See* CAL. FARM WATER COAL., *supra* note 123; *Farm, Business Groups Call for Action on Water Projects*, VALLEY VOICE (July 7, 2022), https://www.ourvalleyvoice.com/2022/07/07/farm-business-groups-call-for-action-on-water-projects/.

160. CAL. FARM WATER COAL., *supra* note 123.

161. Scanlon et al., *supra* note 21, at 9234.

162. José R. Lopez et al., *Sustainable Use of Groundwater May Dramatically Reduce Irrigated Production of Maize, Soybean, and Wheat*, 10 EARTH'S FUTURE, 1 (2022).

163. *See* Susie Cagle, *'Without Water We Can't Grow Anything': Can Small Farms Survive California's Landmark Water Law?*, THE GUARDIAN (Feb. 27, 2020), https://www.theguardian.com/environment/2020/feb/27/california-groundwater-sgma-law-farmers; VALLEY VOICE, *supra* note 159.

164. *Irrigation & Water Use*, USDA ECON. RSCH. SERV. (last updated May 6, 2022), https://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/; Tom Capehart & Susan Proper, *Corn is America's Largest Crop in 2019*, USDA (July 29, 2010), https://www.usda.gov/media/blog/2019/07/29/corn-americas-largest-crop-2019; *Soybeans Acreage by Year, US*, USDA (Mar. 31, 2023), https://www.nass.usda.gov/Charts_and_Maps/Field_Crops/soyac.php.

165. About 28 of the 60 million irrigated acres in 2017 were for corn for grain, soy, and hay. USDA ECON. RSCH. SERV., *supra* note 164. One third of corn, all hay, and 70 percent of soy grown in the United States is fed to animals. *USDA Coexistence Factsheets – Soybeans*, USDA (Feb. 2015), https://www.usda.gov/sites/default/files/documents/coexistence-soybeans-factsheet.pdf; Capehart & Proper, *supra* note 164.

Animals, especially cows, are inefficient convertors of calories.[166] If all the land used for cattle feed was instead used for chicken feed, America could feed up to another 140 million people, or over 40 percent of the nation's population.[167] Beyond feed, another third of corn is turned into ethanol as fuel instead of food.[168] Lastly, low-density housing sprawl replaced over 7 million acres of farmland, equivalent to 70 percent of all irrigated soy acreage, between 2001 and 2016.[169] Policies that favor high-density housing, food over biofuel, and vegetable or chicken protein over cows can increase food security much more than implementing sustainable yield would decrease it. Sustainable yield is not the straw that will break the camel's back of American food security.

In short, the negative impacts from achieving sustainable yield can be offset by modest policy adjustments. The arguments in favor of the status quo are not strong enough to outweigh the water security, intergenerational equity, ecological, and infrastructural benefits of sustainably managing groundwater.

D. Teachings from the Tufas: Sooner Is Better

The best time to begin implementing sustainable yield was yesterday. The second-best time is today. The longer policymakers wait, the adverse effects of groundwater mining become increasingly irreversible, water security diminishes, and water use becomes more entrenched. The saga of Mono Lake provides a relevant example of these three delay-related problems.

Mono Lake is an inland sea fed by five streams on the eastern side of the Sierra Nevada in California.[170] The lake is famous for its vistas, bird migrations, brine shrimp, and tufas—ghostly, limestone towers.[171] The Mono Lake watershed is hydrologically closed, meaning that all water drains to the lake, and there is no surface or subsurface outflow from the lake.[172] Evaporation is the only natural way for water to leave the system.[173]

In 1940, urbanizing Los Angeles acquired surface appropriations for the streams that feed Mono Lake and diverted that water hundreds of miles to its

166. Alon Shepon et al., *Energy and Protein Feed-to-Food Conversion Efficiencies in the US and Potential Food Security Gains From Dietary Changes*, 11 ENV'T RES. LETTERS 1, 2–3 (2016).

167. *Id*.

168. Capehart & Proper, *supra* note 164.

169. MITCH HUNTER ET AL., FARMS UNDER THREAT 2040 6 (2022); USDA ECON. RSCH. SERV., *supra* note 164.

170. *Mono Basin Streams*, MONO LAKE, https://www.monolake.org/whatwedo/restoration/streams/ (last visited May 25, 2023).

171. Erin Ryan, *From Mono Lake to the Atmospheric Trust: Navigating the Public and Private Interests in Public Trust Resource Commons*, 10 GEO. WASH. J. OF ENERGY AND ENV'T L. 39, 50–52 (2019).

172. Darren L. Ficklin et al., *Effects of Projected Climate Change on the Hydrology in the Mono Lake Basin, California*, 116 CLIMATIC CHANGE 111, 113 (2013).

173. Ryan, *supra* note 171, at 50. Unlike most other lakes, where water may leave the lake via subsurface flow, Mono Lake is the lowest point in its watershed; therefore, all groundwater movement heads towards the lake. Thus, groundwater is not a source of outflow. Ficklin, *supra* note 172, at 113.

city.[174] In 1970, to keep up with urban growth, the city substantially increased diversions from Mono Lake.[175] These diversions shrunk the lake to half its volume, causing formidable air quality issues, hurting the local economy, and posing existential threats to the lake's unique ecosystem.[176] In 1983, the California Supreme Court held that the state needed to minimize impacts to human and environmental uses of the lake caused by LA's diversions under the Public Trust Doctrine.[177] In response, the state's 1994 mandate required lake levels increase from their all-time low of 6372 feet in elevation to 6392 feet.[178] In December of 2022, after forty years of legal advocacy, social activism, and extensive state regulation, the lake level was at just 6378.4 feet.[179] This level is meaningfully higher than the all-time low, but still thirteen feet short of the target level.[180] The same air quality and ecological issues still haunt the area, and will continue to for the foreseeable future.[181]

Mono Lake shares many parallels with aquifers.[182] Under natural conditions, both Mono Lake and aquifers hold a relatively stable volume of water that has accumulated over centuries.[183] LA's diversions from Mono Lake act similarly to wells that pump groundwater from aquifers, with both diminishing the elevation of the waterbody.[184] Just as adverse effects from over pumping increase with decreasing aquifer levels, the adverse effects of diverting water from Mono Lake increase with decreasing lake elevation.[185] Unlike contemporary Mono Lake, most current groundwater policies treat aquifers as Mono Lake was treated prior to the California Supreme Court case, allowing

174. Ryan, *supra* note 171, at 51.

175. *Id.* at 52.

176. *Id.* at 52–53.

177. Nat'l Audobon Soc'y v. Super. Ct. of Alpine Cty., 33 Cal. 419, 452–53 (1983).

178. *Id.* at 445–47; MONO LAKE BASIN WATER RIGHT DECISION 1631, CAL. WATER RES. CONTROL BD. 156–59 (1994).

179. *State of the Lake*, MONO LAKE, https://www.monolake.org/learn/stateofthelake/ (last visited May 25, 2023).

180. *Id.*

181. Bartshe Miller, *Covering Up the Air Quality Problem at Mono Lake: Just Add Water*, MONO LAKE (Oct. 26, 2021), https://www.monolake.org/today/covering-up-the-air-quality-problem-at-mono-lake-just-add-water/; Ryan Garrett, *Gull Protection Fence to Go Up in 2023*, MONO LAKE (Dec. 5, 2022), https://www.monolake.org/today/gull-protection-fence-to-go-up-in-2023/.

182. Mono Lake is not unique among lakes in sharing similar management challenges as aquifers. Other shrinking surface bodies of water, such as Lake Powell, Lake Mead, and the Great Salt Lake, experience similar issues. *See Drought in the Colorado River Basin*, USGS, https://www.usgs.gov/special-topics/colorado-river-basin/science/drought-colorado-river-basin (last visited May 25, 2023); Terry Tempest Williams, *I Am Haunted by What I Have Seen at Great Salt Lake*, N.Y. TIMES (Mar. 25, 2023), https://www.nytimes.com/2023/03/25/opinion/great-salt-lake-drought-utah-climate-change.html. Mono Lake is unique in that it has a court-ordered, state-enforced lake elevation level and a relatively long history of struggling to achieve that level. *See State of the Lake*, *supra* note 179.

183. *See Mono Lake Levels 1850-Present (Yearly)*, MONO BASIN CLEARINGHOUSE, https://www.monobasinresearch.org/data/levelyearly.php(last visited May 25, 2023); *see, e.g.*, USGS, GROUNDWATER AVAILABILITY OF THE CENTRAL VALLEY AQUIFER, CALIFORNIA 53 (2009).

184. *See, e.g.,* Scanlon, *supra* note 21, at 9321; *see also State of the Lake*, *supra* note 179.

185. *See also* Ryan, *supra* note 171, at 52–53; *infra* Part I.A.

rapid drawdown of levels with little regard for adverse effects. And as with Mono Lake, the longer policymakers fail to regulate groundwater overuse, the three interconnected issues of increasingly entrenched usage, and decreased water security, and worsening adverse effects become more acute and difficult to reverse.

First, like how allowing more development of Mono Lake water further entrenched the over usage problem, allowing further development of groundwater will further entrench over pumping. Once Los Angeles residents came to rely on the second, larger diversion from Mono Lake, the thought of giving up that precious water became impossible.[186] Had regulation occurred before the construction of the second diversion, L.A. would rely less on the unsustainable use of the lake's water. Had L.A. relied less on unsustainable use, achieving the target lake elevation would be easier because L.A.'s total reductions in usage would be less. With aquifers, brand new wells that irrigate new farmland are currently being drilled into rapidly diminishing aquifers.[187] These brand-new wells act similarly to the second diversion from Mono Lake, increasing overall reliance and entrenching unsustainable use of groundwater.[188] Any new development of groundwater in over pumped basins makes achieving sustainable yield increasingly difficult.

Second, similar to how the lack of regulation for Mono Lake's water prior to 1994 has made L.A. less resilient to droughts, the current lack of groundwater regulation decreases drought resiliency. While Mono Lake's tributaries provide L.A. with some water, L.A. cannot increase use of that water in dry years because the lake's situation is so dire.[189] In fact, the state has required the city to *decrease* usage in recent drought years.[190] Had intensive management of Mono Lake begun twenty-five years earlier, the lake would have been near its target elevation.[191] Were the lake near its target elevation, L.A. could divert more water in drought years than it currently can while keeping the lake healthy. This result would increase L.A.'s water security during drought. The same holds for aquifers. If regulation intervenes to stabilize levels when the aquifer is still relatively full, users can increase usage during drought years with few adverse effects. However, if the aquifer were substantially depleted to start with, users would increase adverse effects were they to increase usage during a drought.

186. Ryan, *supra* note 171, at 54.

187. *See, e.g.*, Ian James & Rob O'Dell, *Megafarms and Deeper Wells are Draining the Water Beneath Rural Arizona - Quietly, Irreversibly*, AZ CENTRAL (Dec. 5, 2019), https://www.azcentral.com/in-depth/news/local/arizona-environment/2019/12/05/unregulated-pumping-arizona-groundwater-dry-wells/2425078001/ (describing new agricultural wells being drilled into overused, desert aquifers in Arizona).

188. *Id.*

189. Loius Sahagún & Ian James, *As Drought Hammers Mono Lake, Thirsty Los Angeles Must Look Elsewhere for Water*, LOS ANGELES TIMES (Apr. 15, 2022), https://www.latimes.com/california/story/2022-04-15/l-a-gets-less-water-from-mono-lake-due-to-declining-levels.

190. *Id.*

191. *State of the Lake*, *supra* note 179.

When policy interferes earlier, it leaves a bigger water budget for a (non) rainy day fund.

Third, the prospects of ever refilling an overused water source to ameliorate the adverse effects of overuse are dubious. Even after thirty years of state-backed effort and substantial reductions in L.A.'s Mono Lake water use, Mono Lake is far below the target level.[192] Dirty air still haunts the area, and the lake continues to teeter on the verge of ecological collapse.[193] For aquifers, achieving sustainable yield does not refill lost volume or reverse adverse effects. Instead, it merely holds the aquifer level constant and keeps adverse effects to their current amount of damage. As Mono Lake shows, even if there is a court order to go beyond sustainable yield to *increase* aquifer levels, accomplishing that goal may be infeasible when people rely on that water.[194] Further, unlike Mono Lake, where the adverse effects can be mitigated by merely adding water, some impacts of groundwater overdraft, such as subsidence, are functionally irreversible.[195] Saltwater intrusion, subsidence, and diminishing aquifer capacity are all impacts that can be functionally impossible to reverse even if the aquifer is refilled. It is likely that the adverse effects from overusing groundwater will continue for decades, if not indefinitely, after regulation.

The lesson from Mono Lake is that, when a water source is overused, regulating sooner is better because early regulation can prevent further entrenched usage, can increase drought security, and can prevent adverse effects from becoming worse.

II. THE CURRENT STATE OF INTERSTATE WATER REGULATION

To understand how interstate water conflicts are resolved, a basic knowledge of the varieties of state water law regimes is necessary. Surface water law is distinct between the eastern and western United States. In the West, surface water law divides rights by appropriative rights: "[F]irst in time, first in right."[196] In times of scarcity, senior water users get their full water rights filled before junior users get any.[197] Riparianism is the law of the East.[198] Riparianism applies for landowners whose land touches water. Such landowners can make reasonable use of that stream's water but cannot injure downstream users.

Groundwater state law has more variation than surface water law, with five main legal regimes.[199] First, absolute dominion, the origin of groundwater law in the United States, allows users to pump essentially without limits.[200] This

192. *See* Sahagún & James, *supra* note 189.
193. Miller, *supra* note 181.
194. *See also State of the Lake*, *supra* note 179.
195. Amos, *supra* note 70.
196. Klein, *supra* note 64, at 505–06.
197. *Id.*
198. *Id.* at 503–05.
199. Leshy, *supra* note 30, at 1480.
200. Dellapenna, *supra* note 25, at 272–73.

approach has been mostly abandoned.[201] Second, some states follow a groundwater version of appropriative rights.[202] Third, the Restatement Rule acts similarly to riparianism, where users must not cause unreasonable harm to other water users.[203] Fourth, correlative rights gives users the right to pump the amount of groundwater proportional to their overlying estate.[204] Lastly, reasonable use allows users to use as much water as they need, as long as that use is reasonable.[205]

A. Methods to Divide Interstate Waters

There are three methods to divide interstate waters in the United States: congressional apportionment, judicial apportionment, and interstate compact.[206] Congressional apportionment is moribund. Congress has apportioned just two bodies of water, and both times the apportionment had some element of state input.[207] Interstate compacts are, by far, the most used method of dividing interstate waters.[208] Most watersheds in the arid Mountain West, along with many watersheds in the southern Great Plains are governed by interstate compacts.[209] Lastly, judicial apportionment allows states to seek a court decree dividing interstate waters.[210] The Supreme Court, which has original jurisdiction over all interstate water apportionment,[211] has only divided three rivers through equitable apportionment: the Laramie River,[212] the North Platte River,[213] and the Delaware River.[214] Scholars,[215] judges,[216] and states[217] widely prefer

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201. *Id.* at 274–75.

202. *Id.* at 300.

203. Restatement (Second) of Torts § 858 (1979).

204. Dellapenna, *supra* note 25, at 276–77.

205. *Id.* at 285.

206. Nathan Weinert, *Solutions for Interstate Groundwater Allocation and the Implications of* Day, 44 TEX. ENVTL. L. J. 105, 114–15 (2014).

207. Since Congressional apportionment seems unlikely for groundwater, I will not address it further in this paper. *See* Joseph Wehr, *The Canary in the Coal Mine: The Apalachicola-Chattahoochee-Flint River Basin Dispute and the Need for Comprehensive Interstate Water Allocation Reform*, 66 ALA. L. REV. 203, 205–06 (2014).

208. INTERSTATE COUNCIL ON WATER POL'Y, INTERSTATE WATER RESOURCE MANAGEMENT AGREEMENTS AND ORGANIZATIONS 1 (2020).

209. *See id.* at 11.

210. *See* Kansas v. Nebraska, 574 U.S. 445, 453–55 (2015).

211. The Court appoints a Special Master to conduct fact finding. The Special Master creates a report, which the Court relies heavily on when making any apportionment decisions. *See, e.g.*, Report of the Special Master February 14, 2017, Florida v. Georgia, 138 S. Ct. 2502 (2018) (No. 142), 2017 WL 656655 (findings of the special master in *Florida v. Georgia*).

212. *See generally* Wyoming v. Colorado, 259 U.S. 419 (1922).

213. *See generally* Nebraska v. Wyoming, 325 U.S. 598 (1945).

214. *See generally* New Jersey v. New York, 283 U.S. 336 (1931).

215. Hall & Cavataro, *supra* note 48, at 1570.

216. *Nebraska v. Wyoming*, 325 U.S. at 616.

217. Douglas S. Kenney, *Water Allocation Compacts in the West: An Overview*, NAT. RES. L. CTR., UNIV. OF COLO. SCH. OF L. 1 (2002).

compacts to judicial decrees because compacts retain state power over the character, development, and implementation of dividing surface waters.

While a significant percentage of interstate surface waters across the nation are apportioned in one way or another, no such structure exists for interstate aquifers.[218] The closest example of interstate groundwater management emerged from litigation over the Republican River Compact. Kansas and Nebraska are both states in that compact.[219] Kansas sued Nebraska after Nebraska failed to let enough water pass down the river in accordance with the compact, largely due to decreased surface water flows caused by increased groundwater pumping.[220] In 2002, those states settled the litigation, "charg[ing] Nebraska for its depletion of the Basin's stream flow due to groundwater pumping."[221] Importantly, the settlement prohibited drilling new wells within the river basin in Nebraska.[222] With the exception of a few minor compact provisions like this, pumping of interstate aquifers is not regulated beyond state law.[223]

This lack of interstate groundwater regulation recently culminated in *Mississippi*, where Mississippi sought damages from Tennessee for suctioning 400 billion gallons of groundwater from Mississippi's sovereign territory across the border.[224] The Court resisted Mississippi's plea to recoup damages, instead holding that equitable apportionment was the appropriate judicial remedy for interstate aquifer disputes.[225]

The equitable apportionment doctrine applies to interstate resources that naturally flow between states.[226] Before *Mississippi*, the Court had only applied equitable apportionment to surface waters and anadromous fish.[227] The Court found equitable apportionment was the appropriate remedy for the Mississippi dispute because the Middle Claiborne Aquifer was a flowing interstate resource.[228] Though the cone of depression caused by Tennessee affected Mississippi, the Court did not get to the merits of the case. Instead, the Court dismissed the case since Mississippi never sought equitable apportionment as a remedy.[229] *Mississippi* expanded the contours of the equitable apportionment

218. Hall & Cavataro, *supra* note 48, at 1570–72 (discussing lack of groundwater compacts). As *Mississippi* shows, there is currently no judicial apportionment of interstate aquifers. *See generally* Mississippi v. Tennessee, 595 U.S. 15 (2021). Congress has also not used its powers to apportion groundwater.

219. INTERSTATE COUNCIL ON WATER POL'Y, *supra* note 208, at 11.

220. Kansas v. Nebraska, 574 U.S. 445, 457–58 (2015).

221. *Id*.

222. Aaron M. Popelka, *The Republican River Dispute: An Analysis of the Parties' Compact Interpretation and Final Settlement Stipulation*, 83 NEB. L. REV. 596, 624 (2004).

223. Hall & Cavataro, *supra* note 48, at 1570–72.

224. *See* Oral Argument at 0:33–1:25, Mississippi v. Tennessee, 595 U.S. 15 (2021) (No. 143), https://www.oyez.org/cases/2021/143-orig.

225. *See generally* Mississippi v. Tennessee, 595 U.S. 15 (2021).

226. *Id.* at 24–25.

227. *Id.* at 24.

228. *Id.* at 24–25.

229. *Id.* at 26–29.

doctrine to include groundwater, but the Court did not indicate *how* it would use the doctrine to resolve groundwater disputes.

B. The Surface Water Equitable Apportionment Doctrine

To understand how the Court might apply equitable apportionment to groundwater, it is necessary to understand how it works in the surface water context. The equitable apportionment doctrine is difficult for states to work with, both because of procedural challenges to establishing a prima facie case and because the substantive doctrine is unpredictable. This Subpart examines the substantive doctrine. It then briefly summarizes two of the three cases where the Court apportioned surface waters to provide examples of how the doctrine is applied. It also discusses the procedural hurdles states face and summarizes the most recent surface water case that was dismissed on procedural grounds.

The equitable apportionment test is best understood through the lens of its two main policy goals: fairness and flexibility. The Court typically equates fairness with upholding the status quo.[230] The Court finds flexibility helpful to resolve water problems that neither Congress nor state legislatures have solved.[231] Since statutory law does not exist to guide apportionments, the Court uses flexibility to help guide its trepidatious creation of federal common law.[232] Overall, the equitable apportionment doctrine aims to "prospectively ensure[] that a State obtains its equitable share of a resource."[233]

Crafting an apportionment requires the "delicate adjustment of interests" by using state law as the guiding principle, but also considering "all relevant factors."[234] "All relevant factors" have included available water supply, local climate, extent of water use, relative benefits and costs to each state, ecosystem services, and the relevant water conservation measures taken by water users.[235]

Data and fact finding is a challenge in equitable apportionment cases. These cases are fact-intensive, and the Supreme Court has original jurisdiction, meaning no lower court helps to develop the factual record. To remedy this dearth of fact finding, the Supreme Court appoints a Special Master to examine the record and craft a report with suggestions on how to resolve the case.[236] Even so, data deficiencies often remain. The Court can, and has, mitigated the shortcomings from data deficiencies by revisiting equitable apportionment

230. Water law expert Dan Tarlock wrote, "[T]he Court defines a fair share primarily in terms of the protection of established uses." DAN TARLOCK, LAW OF WATER RIGHTS AND RESOURCES § 10:16 (1988). "We recognize that the equities supporting the protection of existing economic will usually be compelling." Colorado v. New Mexico, 459 U.S. 176, 187 (1982).

231. Florida v. Georgia, 138 S. Ct. 2502, 2527 (2018) (*Florida I*).

232. *See id.* (citing Virginia v. West Virginia, 220 U.S. 1, 27 (1911)).

233. Idaho ex rel. Evans v. Oregon, 462 U.S. 1017, 1025 (1983).

234. Nebraska v. Wyoming, 325 U.S. 598, 618 (1945).

235. *See id* at 599; Colorado v. New Mexico, 459 U.S. 176, 183, 185–86 (1982).

236. *See, e.g.*, Report of the Special Master February 14, 2017, *Florida I*, 138 S. Ct. 2502 (No. 142), 2017 WL 656655.

decrees decades after their initial decision.[237] The Court claims it will not use "the difficulty of providing equitable relief" to "provide[] an excuse for shirking the duty imposed on [the Court] by the Constitution."[238]

Scholars have criticized the doctrine at length,[239] claiming that "unpredictability is the hallmark of equitable apportionment litigation."[240] This unpredictability is partly due to a lack of precedent and partly due to the Court embracing flexibility when deciding these cases. In terms of precedent, the Supreme Court has only apportioned three rivers, with the last initial apportionment in 1945.[241] It has dismissed six other equitable apportionment cases on procedural grounds.[242] The following two examples, from *Wyoming v. Colorado* in 1922 and *Nebraska v. Wyoming* in 1945, demonstrate how the Court has apportioned surface waters in practice.

The Court's first judicial apportionment was of the Laramie River, which flows from Colorado into Wyoming.[243] At the time, Wyoming used the lion's share of the river's flow.[244] Colorado planned to divert much of the river to irrigate new land with the proposed Laramie-Poudre project.[245] Wyoming sued, claiming that its rights were senior to Colorado's and that there was not enough water in the river to supply the proposed project.[246] Wyoming did not want Colorado, the upstream state, to suck the river dry before it reached Wyoming's border. The Court's analysis began by determining the river's "fairly dependable supply," which was 288,000 acre-feet per year.[247] The Court held that each state had "a duty to exercise her [water] right reasonably and in a manner calculated to conserve the common supply."[248] Then, the Court determined that Wyoming had senior rights to 272,500 acre-feet per year.[249] Though Wyoming claimed it had rights to more water than this, the Court constrained Wyoming's rights to

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237. New Jersey v. New York, 347 U.S. 995, 996 (1954) (changing the apportionment of the Delaware River over twenty years after that river's initial apportionment).

238. *Idaho ex rel. Evans v. Oregon*, 462 U.S. at 1038.

239. Justin Newell Hesser, *The Nature of Interstate Groundwater Resources and the Need for States to Effectively Manage the Resource through Interstate Compacts*, 11 WYO. L. REV. 25, 40–41 (2011); Hall & Cavataro, *supra* note 48, at 1593.

240. Douglas L. Grant, *Collaborative Solutions to Colorado River Water Shortages: The Basin States' Proposal and Beyond*, 8 NEV. L. J. 964, 991.

241. *See* Nebraska v. Wyoming, 325 U.S. 589 (1945); Wyoming v. Colorado, 259 U.S. 419 (1922); *New Jersey v. New York*, 283 U.S. at 336.

242. *See* Washington v. Oregon, 297 U.S. 517 (1936); *Idaho ex rel. Evans v. Oregon*, 462 U.S. 1017; Kansas v. Colorado, 206 U.S. 46 (1907); *Florida I*, 138 S. Ct. 2502 (2018); Connecticut v. Massachusetts, 282 U.S. 660 (1931); Colorado v. New Mexico, 459 U.S. 176 (1982).

243. *See Wyoming v. Colorado*, 259 U.S. 419.

244. *Id.* at 495–96.

245. *Id.* at 490–91.

246. *Id.* at 419–20.

247. *Id.* at 486–88. The "fairly dependable supply" is somewhere between the lowest natural discharge and the average discharge. *Id.* at 483–84.

248. *Id.* at 484.

249. The Court calculated reasonable use by multiplying the number of acres irrigated by the acre-feet of water each area of land needed. This amount varied from one to two and a half acre-feet per acre depending on conditions. *Id.* at 496.

the "amount of water appropriated and reasonably required" for irrigation of currently cultivated lands.[250] This left the Laramie-Poudre project with rights to the remaining 15,500 acre-feet of water.[251] This means the equitable sharing of this river left Colorado with just five and a half percent of the fairly dependable supply.

While the Laramie River was not over appropriated at the time of apportionment, the North Platte River was.[252] Nebraska sued Wyoming and Colorado over use of that river.[253] At the time, the North Platte region was in the midst of a thirteen-year drought.[254] Its over appropriation mostly injured Nebraska, the downstream state and the largest water user.[255] Though no end to the drought was in sight, the Court did not let a lack of perfect data, predictability, or the difficulty of providing a remedy from preventing apportionment.[256] The Court used flexibility when splitting the river, with Colorado and the upper part of Wyoming getting rights to all their prior usage in terms of acre-feet. The lower part of Wyoming and Nebraska split the remaining flow 25 and 75 percent, respectively. [257] Splitting the flow into percentages solved the issue of over apportionment since it assigned Wyoming and Nebraska rights to a ratio of the actual flow rather than a fixed number of acre-feet.

In *Nebraska*, the Court found that a genuine controversy existed merely because the river was over appropriated.[258] However, in the cases since 1945, the Court has introduced many procedural hurdles that prevent states from getting judicial apportionment of over appropriated surface waters. Today, the Court is more likely to dismiss equitable apportionment cases on procedural grounds than decide the case on the merits.[259] This hesitancy to apportion rivers stems from the Court's unease in using its "extraordinary authority to control the conduct of coequal sovereign[s]."[260]

Proving injury, causation, and redressability are the biggest challenges to establishing a justiciable case. Petitioning states must show clear and convincing evidence of injury.[261] The Court has frequently declined to apportion waters by

250. *Id.* at 495–96.
251. *Id.* at 496.
252. *Id.*; Nebraska v. Wyoming, 325 U.S. 596, 650 (1945).
253. Prior to apportionment, the irrigated acreage was 12 percent in Colorado, 29 percent in Wyoming, and 59 percent in Nebraska. *Nebraska v. Wyoming*, 325 U.S. at 597.
254. *Id*. at 599.
255. *See id*.
256. "No one kn[ew] whether [the drought had] run its course or whether it represent[ed] a new norm." *Nebraska v. Wyoming*, 325 U.S. at 620; *see Florida I*, 138 S. Ct. 2502, 2513–14 (2018). "Uncertainties about the future . . . do not provide a basis for declining to fashion a decree." Idaho ex rel. Evans v. Oregon, 462 U.S. 1017, 1026 (1983).
257. *Nebraska v. Wyoming*, 325 U.S. at 646.
258. *Id.* at 608.
259. *See, e.g.*, Mississippi v. Tennessee, 142 S. Ct. 31, 42 (2021) (dismissing on procedural grounds).
260. Florida v. Georgia, 141 S. Ct. 1175, 1183 (2021) (*Florida II*).
261. *Mississippi v. Tennessee*, 595 U.S. at 28.

finding the petitioning state has not suffered sufficient injury to bring a claim.[262] The recent decisions regarding the Apalachicola River system, discussed below, emphasized the challenge of establishing causation.[263] Finally, the petitioning state must show that an apportionment would remedy their injury.[264] Redressability has been a difficult issue for petitioning states to overcome throughout the lifespan of the doctrine.[265]

Dismissal on procedural grounds was most recently demonstrated in *Florida v. Georgia* (*Florida I*) and *Florida v. Georgia* (*Florida II*). Florida sued Georgia over its rapidly increasing use of water in the Apalachicola River. The river feeds Florida's Apalachicola Bay, "one of the most productive estuaries in the northern hemisphere" that once provided 10 percent of the nation's oysters.[266] The Special Master's report found that Georgia had increased the acres irrigated with Apalachicola water eleven-fold over the last fifty years, taking "few measures" to conserve water.[267] Georgia's increased consumption diminished flows into Bay, therefore increasing the Bay's salinity.[268] Increased salinity harms oysters.[269] After the oyster population collapsed, Florida closed the famous fishery from 2020 until 2025.[270] The Special Master found that the "evidence presented tended to show that increased salinity rather than harvesting pressure caused the collapse."[271] However, this evidence was not enough to establish causation, so the Court remanded the case to the Special Master to specifically determine whether Florida had suffered harm because of reduced flow, and whether Georgia had *caused* that harm.[272]

After more factfinding, the *Florida II* Court held that Florida had not proved that Georgia caused Florida's injury. The Court found that factors beyond Georgia's increased use, such as climate change, drought, and overfishing, may have caused the oyster fishery's collapse.[273] The Court also found there was a "complete lack of evidence" that reduced river flows harmed Florida's wildlife.[274]

262. Washington v. Oregon, 297 U.S. 517, 526 (1936); Idaho ex rel. Evans v. Oregon, 462 U.S. 1017, 1028–29 (1983); *Florida II*, 141 U.S. at 1175; Connecticut v. Massachusetts, 282 U.S. 660, 672 (1931).

263. *Florida II*, 141 S. Ct. at 1180–82.

264. *Florida I*, 138 S. Ct. 2502, 2516–17 (2018).

265. *Id.* at 2520; *Idaho ex rel. Evans v. Oregon*, 462 U.S. at 1030 (O'Connor Dissent); *Washington v. Oregon*, 297 U.S. at 522–23.

266. Report of the Special Master, *supra* note 211, at 8–9.

267. *Id.* at 32–33.

268. *Id.* at 31–32.

269. *Id.*

270. *Oysters*, FLA. FISH & WILDLIFE CONSERVATION COMM'N, https://myfwc.com/fishing/saltwater/commercial/oysters/ (last visited May 27, 2023).

271. Report of the Special Master, *supra* note 211, at 14.

272. *Florida I*, 138 S. Ct. 2502, 2527 (2018).

273. *Florida II*, 141 U.S. 1175, 1180–82 (2021).

274. *Id*. at 1183.

In addition to strengthening the causation requirement, the *Florida II* Court also introduced a new balancing element as a barrier to bringing an equitable apportionment claim. The Court ruled that Florida could only get to the merits of the case if it showed that the benefit of judicial apportionment would "*substantially outweigh* the harm that might result."[275] Under this new standard, the benefits from equitable apportionment to the petitioning state must outweigh injury to other states.[276]

Florida II, and to some extent *Mississippi*, demonstrate that the Court is not eager to use its power to apportion interstate waters. Any state seeking judicial apportionment will likely get dismissed on procedural grounds or fail to get the Court to take their case. If the petitioning state succeeds to the substantive doctrine, precedent gives that state little idea of how the Court will decide the case.

C. The Current Test Will Encourage Further Aquifer Mining

The most likely outcome for an interstate groundwater dispute under the Court's current equitable apportionment test is dismissal on procedural grounds. Assuming the Court decides a case on the merits with its current test, it is unlikely to use sustainable yield as a North Star.[277] The Court's protection of established uses, reluctance to value conservation, and the importance of cost-benefit analysis all point away from a decree that achieves sustainable yield.[278]

The Court's preference to protect established uses favors further aquifer depletion. Protecting established uses is generally not as problematic for surface

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275. *Id.* at 1180 (emphasis added). The Court introduced the balancing test out of a mischaracterization of the holding in *Colorado v. New Mexico*, 459 U.S. 176 (1982). That case used a balancing test for the narrow purpose of determining whether a *proposed diversion* should be considered along with prior appropriations, rather than whether an entire *apportionment* is justiciable.

> The harm that may result from disrupting established uses is typically certain and immediate, whereas the potential benefits from a *proposed diversion* may be speculative and remote. Under some circumstances, however, the countervailing equities supporting a *diversion for future use* in one state may justify the detriment to existing users in another state. This may be the case, for example, where the state *seeking a diversion* demonstrates by clear and convincing evidence that the benefits of the *diversion* substantially outweigh the harm that might result. In the determination of whether the state *proposing the diversion* has carried this burden, an important consideration is whether the existing users could offset the *diversion* by reasonable conservation measures to prevent waste.

Id. at 187 (emphasis added). In fact, since Georgia was the state increasing its diversions from the river in *Florida I* and *II*, the language from *New Mexico* should have worked against Georgia, the diverting state. Instead, the Court read *New Mexico* to work against Florida, the state seeking to maintain the status quo.

276. *Florida II*, 141 S. Ct. at 1180.

277. Whether requiring users to decrease pumping would implicate the takings clause of the Constitution is beyond the scope of this paper. For a discussion of takings and groundwater, *see* David Owen, *Taking Groundwater*, 91 WASH. UNIV. L. REV. 253 (2013).

278. *See Florida II*, 141 S. Ct. at 1180–81; *Colorado v. New Mexico*, 459 U.S. at 186–87.

waters' longevity because users are limited to using one year's runoff.[279] When the Court protects established surface water uses, the users from one year have little to no effect on the supply of users ten years down the line. Aquifers, in contrast, can be rapidly depleted of hundreds of years of recharge, affecting water supply for generations.[280] To prove injury, a state must demonstrate that established groundwater uses are unsustainable. However, protecting those established uses would ensure further depletion of the aquifer. Achieving sustainable yield for any interstate aquifer with a major dispute will require substantial changes to existing water uses, which is something the Supreme Court has never done.[281]

The Court's devaluation of conservation in its three most recent apportionment decisions likewise favor aquifer drawdown.[282] First, in *Idaho ex rel. Evans v. Oregon*, the Court considered whether Idaho was entitled to an equitable apportionment of the Snake River's threatened salmon. These stalwart fish pass through the entirety of Oregon and Washington before entering Idaho.[283] The Court held that because the fish population was already diminished, Idaho could not suffer harm from that diminished resource going into the future.[284] Conserving the remaining fish did not amount to "ameliorating present harm and preventing future injuries" for Idaho.[285] Since prior exploitation of fish, which decreased overall population, failed to establish injury, prior exploitation of an aquifer which decreases overall water supply may also fail to establish injury.[286]

Second, in *Colorado v. New Mexico*, the Court considered Colorado's proposition to divert water from the fully-allocated Vermejo River to open a new industrial facility.[287] The Special Master found that Colorado's proposed diversion would be overall beneficial, since any cuts in water usage would be made by New Mexico's Conservancy District, which operated a wildlife refuge. While the Court did not enter a judicial decree, it did not refute the Special Master's finding that the Conservancy District was the Vermejo River's least important user because it had "never been an economically feasible

279. Storage reservoirs allow surface water users to use water from prior years, but not nearly to the same extent as aquifers, which store centuries worth of water. *See* Campa, *supra* note 112 (showing storage capacity on the Colorado River).

280. *See* Robert R.M. Verchick, *Dust Bowl Blues: Saving and Sharing the Ogallala Aquifer*, 14 J. OF ENV'T L. AND LITIG. 13, 13, 17 (1999).

281. The closest the Court has come to substantially changing existing uses was in *Nebraska v. Wyoming*, where it split water between those two states on a basis other than prior appropriation, requiring less water use from both states. Nebraska v. Wyoming, 325 U.S. 598, 644–46 (1945).

282. *See Florida I*, 138 S. Ct 2502, 2529–30 (2018); *Florida II*, 141 S. Ct. at 1180–82; *Colorado v. New Mexico*, 459 U.S. at 180–81; Idaho ex rel. Evans v. Oregon, 462 U.S. 1017, 1029 (1983).

283. *Idaho ex rel. Evans v. Oregon*, 462 U.S. at 1017.

284. *Id.* at 1027–28.

285. *Id.* at 1028.

286. *See generally id.*

287. *Colorado v. New Mexico*, 459 U.S. at 180–81.

operation."[288] If the Court values conservation as little as it did in *New Mexico* for a groundwater appropriation, it will likely allow continued groundwater mining over sustainable yield.

Third, in *Florida II*, the Court's holding favored Georgia's agricultural development over maintaining Florida's oyster fisheries and environmental uses of the Apalachicola River.[289] While the facts established in that case proved that letting more water reach the Apalachicola estuary would benefit the oysters and surrounding habitat, the Court denied Florida relief.[290] Even accepting the Court's claim that climate change and drought were the culprits of oysters' demise, *Florida II* is in tension with *Nebraska*.[291] In *Nebraska*, the Court found a controversy existed precisely because the river was overused due to a thirteen-year long drought.[292] In *Florida II*, however, the Court used drought as an excuse to avoid appropriation of an overused river. One explanation for the incongruence between the two cases is that downstream users in Nebraska used the water for agricultural purposes[293], while the downstream users in the Florida used the water for habitat conservation purposes.[294]

In both *New Mexico* and *Florida II*, the Court preferred results that favored greater economic activity over resource conservation. Achieving sustainable yield of an overdrawn aquifer requires the implementation of stringent water conservation while forgoing economic activity in the short-term, directly colliding with the reasoning in *New Mexico* and *Florida II*.[295] Taken together, with *Idaho*, these cases demonstrate that an ethic of conservation does not compel the Supreme Court in equitable apportionment decisions.

The Court also greatly emphasized the significance of a cost-benefit analysis in *Florida II*.[296] This new emphasis encourages depletion of an aquifer instead of sustainable use. The Court tends to heavily favor easily quantifiable, immediate benefits and costs compared to less direct benefits and costs.[297] The

288. *Id.* at 178. The other, more important, users were Kaiser Steel, Phelps Dodge, and Vermejo Park Corporation.

289. *See Florida II*, 141 S. Ct. 1175, 1183 (2021); *Florida I*, 138 S. Ct. 2502, 2529 (2018) (Thomas, J., dissenting) ("Georgia accounts for 98% of the population and 99% of the economic production."). By refusing to apportion the river, the Court chose to offer no relief to Florida's ecosystems and oysteries.

290. *See Florida I*, 138 S. Ct. at 2518–19.

291. *Compare Florida II*, 141 S. Ct. at 1182 ("[E]vidence . . . indicates that the unprecedented series of multiyear droughts, as well as changes in seasonable rainfall patterns, may have played a significant role."), *with* Nebraska v. Wyoming, 325 U.S. 589, 620 (1945) ("No one knows whether [the drought] has run its course or whether it represents a new norm. There is no reliable basis for prediction. But a controversy exists; and the decree which is entered must deal with conditions as they obtain today.").

292. *Nebraska v. Wyoming*, 325 U.S. at 599, 620.

293. *Id.* at 599, 608.

294. *Florida II*, 141 S. Ct. at 1182–83.

295. HANAK ET AL., *supra* note 124, at 5–6.

296. *Florida II*, 141 S. Ct. at 1180.

297. *Cf.* Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607, 645–46 (1980); Michigan v. EPA, 576 U.S. 743, 752, 764 (2015). The *Michigan* majority held that "[o]ne would not say that it is even rational, never mind 'appropriate,' to impose billions of dollars in economic costs in return for a few dollars in health or environmental benefits." Yet the dissent found "EPA conducted a formal cost-benefit

costs of implementing sustainable yield are relatively clear, immediate, and visible—job loss, less agricultural productivity, and land fallowing.[298] Pumping aquifers for agriculture brings tens of billions of dollars annually to regions without other industries.[299] The benefits of constraining overdraft are harder to quantify, further off, and hidden—better water security, increased base flow for surface waters, and decreased subsidence. Quantifying the benefits of avoiding "Day Zero," for example, is an uncertain and difficult enterprise. Only when the well is dry do we know the worth of water. The Court's new requirement that the benefits of apportionment must outweigh the costs may preclude states from establishing a prima facie interstate groundwater case.[300]

The most likely outcome of a groundwater equitable apportionment case under the Court's current test is dismissal for failure to show injury or causation. If a state clears the myriad procedural challenges, the Court is unlikely to use sustainable yield as a starting place to apportion waters because it values economic activity and the status quo over conservation. [301]

III. CONGRESS MUST INCENTIVIZE INTERSTATE GROUNDWATER COMPACTS

Since the Supreme Court is unlikely to apportion an interstate aquifer, and even more unlikely to do so quickly and with sustainability in mind, states should aggressively pursue interstate groundwater compacts to avert catastrophe. Even if the Court is interested in apportioning groundwater, states should pursue their own compacts. Compacts can be quicker, more prolific, and better tailored to state needs than judicial decree. States have better access to information and

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study which found that the quantifiable benefits of its regulation would exceed the costs up to nine times over—by as much as $80 billion each year."

298. *See* HANAK ET AL., *supra* note 124, at 5–6; Lopez et al., *supra* note 162, at 1.

299. *See* Cruse et al., *supra* note 45, at 153.

300. *See Florida II*, 141 S. Ct. at 1180.

301. Even if the Court did try to craft a decree, the Court would find their current test is not administrable for interstate groundwater. In contrast to surface water, using state law as equitable apportionment's guiding principle would be difficult to administer for groundwater. State law is a good guide for surface water apportionments because the laws between litigating states tend to stem from the same legal regime. Due to geographic clustering of riparianism and prior appropriation, all apportionment cases, except for *Kansas v. Colorado*, have involved states that follow either appropriative rights or riparian rights. Kansas v. Colorado, 206 U.S. 46 (1907); Connecticut v. Massachusetts, 282 U.S. 660 (1931) (riparian); Colorado v. New Mexico, 459 U.S. 176 (1982) (prior appropriation); Washington v. Oregon, 297 U.S. 517 (1936) (prior appropriation); Nebraska v. Wyoming, 325 U.S. 596 (1945) (prior appropriation); Idaho ex rel. Evans v. Oregon, 462 U.S. 1017 (1983) (prior appropriation); New Jersey v. New York, 283 U.S. 336 (1931) (riparianism); Wyoming v. Colorado, 259 U.S. 419 (1922) (prior appropriation); *Florida I*, 138 S. Ct. 2502 (2018) (riparianism). In contrast, groundwater law shares no geographic clustering and has a much higher diversity of legal regimes. Instead of two main bodies of law in the surface water context, there are at least five main bodies of groundwater law. *See* Dellapenna, *supra* note 25, at 269; TEX. WATER DEV. BD., *supra* note 24, at 25–26. These different bodies of law frequently govern neighboring states that overlie a single aquifer. For example, the neighboring states of Texas, Kansas, and Oklahoma that overlie the Ogallala Aquifer follow absolute dominion, prior appropriation, and correlative rights laws, respectively. *Id.*

oversight, can better implement, have more flexibility in drafting conditions, and can create a more adaptive compact than the Court.[302]

A. Congressional Carrots: Reclamation and the Central Arizona Project

In the past, Congress regularly incentivized interstate surface water compacts by withholding federal funding for big water projects until benefitting states negotiated a compact.[303] Congress also funded a huge water project for Arizona, but only on the condition that Arizona pass comprehensive groundwater reform first.[304] Here too, Congress should offer to fund aquifer projects, but only after states successfully negotiate sustainable groundwater compacts.

Congress passed the Reclamation Act in 1902 to build massive water infrastructure projects to provide water for arid farmland and cities in the West.[305] The heyday of Reclamation projects was during the Great Depression and between 1939 and 1974.[306] Twenty-one of the twenty-five interstate surface water compacts were ratified between 1939 and 1971.[307] It isn't a coincidence that those dates line up so well.

States wanted Reclamation projects badly but could not afford to fund such projects on their own, which often had tens-to-hundreds-of-million-dollar price tags.[308] Realizing its leverage, "the Department of the Interior typically required states to resolve interstate water allocation disputes prior to commencing federally funded river basin developments."[309] The federal government did not want to aggravate water wars by building water projects and therefore increasing states' abilities to draw on surface waters.[310] It would rather have states agree on how to divide the water first, and then build huge water storage and transport projects.[311] Currently, Reclamation projects provide water to 31 million people.[312]

One of the most famous Reclamation projects was the Colorado River Storage Project. In 1946, the Bureau of Reclamation published a report that identified 134 potential project sites on the upper Colorado River.[313] The study also explicitly stated that none of the projects would receive federal funding until

302. *See* Kenney, *supra* note 217, at 1.
303. *Id.* at 2.
304. *See* Connall, *supra* note 28.
305. *A Very Brief History*, BUREAU OF RECLAMATION (2018), https://www.usbr.gov/history/borhist.html (last visited June 11, 2023).
306. *Id.*
307. INTERSTATE COUNCIL ON WATER POL'Y, *supra* note 208, at 9–11.
308. Dean E. Mann, *Conflict and Coalition: Political Variables Underlying Water Resource Development in the Upper Colorado River Basin*, 15 NAT. RES. J. 141, 160 (1975).
309. Kenney, *supra* note 217, at 2.
310. *See also* Mann, *supra* note 308, at 144.
311. *See also id.*
312. *About Us – Fact Sheet*, BUREAU OF RECLAMATION (2022), https://www.usbr.gov/main/about/fact.html.
313. Kenney, *supra* note 217, at 2.

the Upper Basin states resolved their water disputes through agreement.[314] The states eventually agreed to a compact, helped by the Bureau's data and technical assistance.[315] The states then benefited from billions of dollars of federal investment in projects like the Glen Canyon Dam, Flaming Gorge Reservoir, and Lake Navajo.[316] Farmers and municipalities that use Colorado River water benefit from the drought-leveling effects of the 30 million acre-feet of water held by the Colorado River Storage Project.[317]

While the Reclamation Act demonstrates how the federal government can incentivize interstate compacts, the history of the Central Arizona Project (CAP) and the Arizona Groundwater Management Act demonstrates how the federal government can leverage infrastructure funding to hasten groundwater legislation. CAP would pipe water over 300 miles of parched desert land from the Colorado River to inland Arizona.[318] Arizona intended to use CAP water to expand irrigation and municipal use.[319] But Congress wanted to be sure that its investment of four billion dollars on a project that would benefit only Arizona would resolve that state's internal water problems rather than aggravating them.[320] Leery of expanding Arizona's water use, Congress billed the project as a "rescue project" and prohibited CAP water from being used to irrigate new fields.[321] Further, Congress forbade Arizona from using CAP water on any area that did not have adequate measures in place to "control expansion of irrigation from aquifers."[322] At that time, Arizona had no meaningful groundwater regulation, so this requirement forced Arizona to enact groundwater management laws if it wished to receive CAP.[323]

This carrot and stick approach was the "first time ever [that] Congress insisted on effective state groundwater law reform as a price for getting federal largesse."[324] Even with construction of the CAP nearly complete in 1980, President Carter's Secretary of the Interior made clear that he intended to fulfill Congress's intent to withhold CAP water until Arizona enacted groundwater reform, which it had yet to accomplish.[325] After lengthy negotiations, Arizona passed the Arizona Groundwater Management Act in 1980, revolutionizing

314. Mann, *supra* note 308, at 144.

315. *Id.* at 145–46.

316. *Id.* at 159–60.

317. *Colorado River Storage Project*, BUREAU OF RECLAMATION (2021), https://www.usbr.gov/uc/rm/crsp/index.html.

318. *Colorado River Basin Project Act*, CENT. ARIZ. PROJECT, https://www.cap-az.com/about/history-of-cap/colorado-river-basin-project-act/ (last visited June 11, 2023).

319. John D. Leshy, *The Federal Role in Managing the Nation's Groundwater*, HASTINGS W.–NW. J. ENVTL. L. & POL'Y 1, 9 (2004).

320. *Id.*; *How Much Did the CAP Canal Cost to Build?*, KNOW YOUR WATER NEWS, https://knowyourwaternews.com/how-much-did-the-cap-canal-cost-to-build/ (last visited June 11, 2023).

321. Leshy, *supra* note 319, at 9.

322. *Id.*

323. Connall, *supra* note 28, at 314–15.

324. Leshy, *supra* note 319, at 9.

325. *See* Connall, *supra* note 28, at 329.

groundwater regulation in Arizona.[326] Chronicling the act's passage, Desmond Connall wrote that "[i]t is difficult to overestimate [the Secretary's] position on [Arizona's] groundwater commission and the legislature. Without this pressure from the Carter administration, a groundwater bill probably would not have been enacted in 1980."[327] Congressional funding for vital projects can turn previously untenable policies into reality.

CAP and the Reclamation projects show that a federal carrot and stick approach can get states to voluntarily negotiate interstate compacts and regulate groundwater sustainably.

B. Potential Federal Incentives for Interstate Groundwater Compacts

Congress and executive agencies should similarly incentivize interstate groundwater compacts. Of paramount importance is that Congress only authorizes compacts that use sustainable yield and prevent groundwater mining. There are many groundwater-related projects the federal government could fund in exchange for negotiated compacts. Developing managed aquifer recharge (MAR) infrastructure, groundwater treatment facilities, and enhanced water efficiency measures are three types of projects the federal government could use to incentivize interstate groundwater compacts.

MAR is the "the purposeful recharge of water to aquifers for subsequent recovery or for environmental benefit."[328] MAR can hasten recharge in various ways.[329] Land and water managers can increase surface infiltration by intentionally flooding agricultural fields or diverting water to dry channels in low-flow seasons.[330] Managers can also use wells for recharge by injecting water into wells and letting it percolate into the aquifer.[331] Popular excess water supplies for MAR include treated wastewater, stormwater runoff, and river

326. *Id.* at 313. While AGMA is not perfect, it was a significant step in groundwater management. Importantly, the Act prevented agriculture expansion and required groundwater reporting. However, the Act only applied to the most urban areas of Arizona, leaving most of the state unregulated. Aquifers in rural areas of Arizona are currently experiencing rapid declines. Impressively, the aquifer underneath Tucson, Arizona's second largest city, achieved sustainable yield in 2015 even while the Tucson's population grew by 60 percent since 1980. Tucson is one of the nation's hottest, driest cities. *See* Ester Loiseleur & Kirsten Engel, *Arizona's Groundwater Management Act at Forty: Tackling Unfinished Business*, 10 ARIZ. J. OF ENV'T L. & POL'Y 187, 192–96 (2020); *Active Management Areas Annual Supply and Demand Dashboard*, ARIZ. DEP'T OF WATER RES., https://new.azwater.gov/ama/ama-data (last visited June 11, 2023).

327. Connall, *supra* note 28, at 330.

328. Peter Dillion & Muhammad Arsha, *Managed Aquifer Recharge in Integrated Water Resource Management*, *in* INTEGRATED GROUNDWATER MANAGEMENT: CONCEPTS, APPROACHES AND CHALLENGES (Anthony J. Jakeman et al. eds., 2016).

329. For a more in-depth explanation of the different kinds of MAR, *see* Heng Zhang et al., *A Review of the Managed Aquifer Recharge: Historical Development, Current Situation and Perspectives*, 118–19 PHYSICS & CHEMISTRY OF THE EARTH 102887 (2020).

330. Katja Luxem, *Managed Aquifer Recharge*, AM. GEOSCIS. INST. (Sept. 2017), https://www.americangeosciences.org/geoscience-currents/managed-aquifer-recharge.

331. Zhang et al., *supra* note 329, at 3.

water.[332] Germany has widely adopted MAR to supply public drinking water. At least 15 percent of that nation's drinking water, and two-thirds of Berlin's water, comes from MAR projects.[333]

States will want funding for MAR projects because MAR can significantly reduce the destruction of storm flooding by moving flood waters from urban areas to open fields.[334] It also helps states improve water security by storing otherwise unused water for future use.[335] MAR helps surface waters, too, improving the flow of adjacent streams in dry seasons.[336]

MAR implementation requires planning, investigation, design, construction, operation, maintenance, and compliance with regulations.[337] Each step requires investment. Managers must have the correct data to pick the best location and project type. Like how the federal government identified 134 project locations for the Colorado River Storage Project, the federal government can produce exhaustive studies identifying the best locations for MAR.[338] While MAR often achieves rapid, localized recharge of over ten meters per year, "uptake has been much lower than expected due to unavailability of strong economic feasibility analysis" and high upfront investment.[339] For example, price per meter of stored water for different types of MAR projects can vary by an order of magnitude.[340] Once a site is identified, site modifications and drilling of wells is often necessary to achieve maximum percolation.[341] Were the federal government to identify the best projects and offer to fund those projects, states may become willing to negotiate groundwater compacts, like how Colorado River states negotiated the Colorado River Compact in response to the Colorado River Storage Project report.[342]

Another area the government could fund is groundwater treatment plants. Groundwater pollution is a serious problem threatening municipal drinking water.[343] Water treatment plants have proven to be successful carrots before. A major reason the House and Senate overwhelmingly overrode president Nixon's veto of the Clean Water Act was because that act provided $60 billion in state

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332. Luxem, *supra* note 330.

333. C. Sprenger et al., *Inventory of Managed Aquifer Recharge Sites in Europe: Historical Development, Current Situation and Perspectives*, 25 HYDROGEOLOGY J. 1909, 1917 (2017).

334. *See also* Declan Page et al., *Managed Aquifer Recharge (MAR) in Sustainable Urban Water Management*, 10 WATER 1, 2 (2018).

335. *Id.*

336. Kourakos et al., *supra* note 85, at 7464.

337. Zhang et al., *supra* note 329, at 3.

338. *See also* Kenney, *supra* note 217, at 216.

339. *See* Kourakos et al., *supra* note 85; Andrew Ross & Sunail Hasnain, *Factors Affecting the Cost of Managed Aquifer Recharge (MAR) Schemes*, 4 SUSTAINABLE WATER RES. MGMT. 179, 180 (2018).

340. Ross and Hasnain, *supra* note 339, at 185.

341. Zhang et al., *supra* note 329, at 3–4.

342. *See also* Mann, *supra* note 308, at 144.

343. Karen R. Burow et al., *Nitrate in Groundwater of the United States, 1991−2003*, 44 ENV'T SCI. & TECH. 4988, 4991 (2010).

funding for wastewater treatment plants.[344] Many municipalities will need to make costly upgrades to their current groundwater treatment plants if they are to remove carcinogenic chemicals, such as per- and polyfluoroalkyl substances, or PFAS.[345] The government could offer funding for these expensive upgrades on the condition of negotiated groundwater compacts.

The federal government can also provide water users with technical assistance to reduce water use and improve irrigation efficiency. For purposes of this Note, technical assistance is when an agency provides expert consultation to farmers, based on the latest research, at low to no cost.[346] This can look like an agency employee visiting a farm and offering advice to the farmer on how to solve problems, or helping a farmer apply for grant funding.[347] Agencies like the Natural Resources Conservation Service already help farmers around the nation with various kinds of technical assistance.[348] Technical assistance is helpful to complement regulation because it builds a voluntary and cooperative relationship between water users and the government, rather than the adverse relationship that characterizes regulation.[349] It also increases a user's likelihood of adopting new practices.[350] As leverage to compel groundwater compacts, Congress could greatly increase investment in technical assistance for implementing efficient irrigation, but only for states that enter interstate groundwater compacts. Implementing more efficient irrigation could offset some of the cuts needed to achieve sustainable yield.[351]

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344. *The Thirty-Fifth Anniversary of the Clean Water Act: Successes and Future Challenges: Hearing before the Committee on Transportation and Infrastructure*, 110th Cong. 3, 5 (2007).

345. Ian T. Cousins et al., *The Precautionary Principle and Chemicals Management: The Example of Perfluoroalkyl Acids in Groundwater*, 94 ENV'T INT'L 331, 333 (2016).

346. *Conservation Technical Assistance*, NAT. RES. CONSERVATION SERV., http://www.nrcs.usda.gov/getting-assistance/conservation-technical-assistance (last visited June 11, 2023).

347. *Conservation Planning*, NAT. RES. CONSERVATION SERV., http://www.nrcs.usda.gov/getting-assistance/conservation-technical-assistance/conservation-planning (last visited June 11, 2023).

348. *Natural Resources Conservation Service*, NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/ (last visited June 11, 2023).

349. *Conservation Technical Assistance Program: How it Works*, NAT. RES. CONSERVATION SERV., http://www.nrcs.usda.gov/getting-assistance/conservation-planning/how-the-conservation-technical-assistance-program-works (last visited June 11, 2023).

350. Jason Konefal et al., *Sustainability Assemblages: From Metrics Development to Metrics Implementation in United States Agriculture*, 92 J. OF RURAL STUDS. 502, 506 (2022); *Conservation Technical Assistance: Benefits*, NAT. RES. CONSERVATION SERV., http://www.nrcs.usda.gov/getting-assistance/conservation-planning/conservation-technical-assistance-benefits (last visited Mar. 18, 2023).

351. Evidence suggests that, in the absence of a regional groundwater plan, increasing irrigation efficiency has the counterintuitive impact of *increasing* groundwater overdraft problems. This is because the rational farmer will use the water and monetary gains from increased efficiency to grow higher value, more water-thirsty crops. C.-Y. Cynthia Lin Lawell, *The Management of Groundwater: Irrigation Efficiency, Policy, Institutions, and Externalities*, 8 ANN. REV. RES. ECON. 247, 249–252 (2016). Also, higher irrigation efficiency means less irrigation water sinks back into the aquifer as recharge. William E. Dench & Leanne K. Morgan, *Unintended Consequences to Groundwater from Improved Irrigation Efficiency: Lessons from the Hinds-Rangitata Plain, New Zealand*, 245 AGRIC. WATER MGMT. 1, 1 (2021). If enhanced efficiency can have the unintended consequence of impairing aquifers more, Congress should remove all funding for irrigation efficiency projects in areas without groundwater compacts and set aside extra money to fund irrigation efficiency projects once a compact specifies how sustainable yield

The above examples represent just three of many levers the federal government can use to reward states that sign interstate groundwater compacts. Any of these federal investments would be wise for increasing water security heading into a climate-changed future.

C. Provisions for Groundwater Compacts

While Congress can provide incentives, states will ultimately be the entities that negotiate the terms of groundwater compacts. States can exercise much more creativity in crafting a compact compared to a judicial apportionment decree. States should take advantage of this creativity by incorporating domestic and international groundwater management successes into their compacts. Buffer zones, well drilling prohibitions, sub-state level basin management, and inclusion of new models are four examples of provisions states should include in their interstate groundwater compacts.

First, states can set a buffer zone around their borders, within which zero to limited pumping occurs. This provision would decrease cone of depression spillover effects, like those experienced in *Mississippi*.[352] An international agreement between Jordan and Saudi Arabia of the shared Disi Aquifer follows this approach by prohibiting pumping within twenty kilometers of the border.[353]

Second, a fair compact should also prohibit drilling new wells in overdrafted areas. After a settlement over the Republican River Compact, Kansas, Colorado, and Nebraska cannot drill new wells overlying the shared, overdrafted aquifer.[354] Preventing new agricultural wells limits users from increasing capital investment and reliance interests on the further exploitation of aquifers.

Third, interstate compacts should manage groundwater at the scale of sub-basins, rather than merely breaking groundwater use into state-by-state allowances. Many sub-basins can straddle a single state line.[355] Managing at the sub-basin level ensures that all parts of an aquifer are being used sustainably.

will be met. This way, Congress can have more confidence that it is using taxpayer dollars to reduce, rather than increase, the problem. After examining the real-world effects of irrigation efficiency projects harming aquifers in Kansas, researchers concluded, "If conservation is truly the goal, policies designed to increase irrigation efficiency must be examined critically, with attention paid to behavioral responses. To achieve conservation, increases in irrigation efficiency must be accompanied by corresponding decreases in the quantity of water that a user is allowed to extract." Lisa Pfeiffer & C.-Y. Cynthia Lin, *Does Efficient Irrigation Technology Lead to Reduced Groundwater Extraction? Empirical Evidence*, 67 J. OF ENV'T ECONS. & MGMT. 189, 202–03 (2014).

352. Mississippi v. Tennessee, 142 U.S. 31 (2021).

353. Marc F. Müller et al., *How Jordan and Saudi Arabia Are Avoiding a Tragedy of the Commons Over Shared Groundwater*, 53 WATER RES. RSCH. 5451, 5463 (2017).

354. Popelka, *supra* note 222, at 624.

355. *See, e.g.*, WELCH ET AL. EDS., *supra* note 35, at 65 (showing four sub-basins of the Snake Valley Aquifer that straddle the Utah-Nevada state line).

This is the approach SGMA takes, splitting the single Central Valley Aquifer into a few dozen sub-basins.[356]

Fourth, a groundwater compact should be drafted to encourage the incorporation of new hydrological and climate science to change sustainable yield determinations. As hydrological models become more sophisticated, they will help states set more accurate sustainable yields.

Provisions such as these would help create an enduring, flexible, creative, and sustainable compact that is responsive to each states' needs.

IV. A Better Doctrine for Groundwater Apportionment

Though compact negotiation is preferable, it's inevitable that some parties to interstate groundwater disputes will seek litigation. When resolving such disputes, the Court should make a new test for groundwater apportionment. Since groundwater is fundamentally different from surface water, a different doctrine stemming from the same policy goals of fairness and flexibility makes sense.[357] This new test proposed here, called *proportional sustainable yield*, limits abstractions to sustainable yield and allocates that yield proportionally to states based on how much they contribute to the aquifer's recharge.

The Court should prioritize interstate groundwater disputes on its docket for two reasons. First, as explained in Subpart II.E, achieving sustainable yield sooner rather than later is highly desirable.[358] Second, if the Supreme Court demonstrates that it will apportion groundwater via sustainable yield, that will set the tone for compact negotiations. Negotiations happen on the fabric of existing law, and if that law centers sustainable yield, states will approach negotiations with sustainable yield in mind. The Court should "remain aware that the States bargain [] for [compact] rights in the shadow of [its] equitable apportionment power" and use that power to push sustainable use.[359]

A. Calculating Proportional Sustainable Yield

It's helpful to think of a pie analogy to visualize water apportionment. With surface water, the Court only needs to decide how large each state's *slice of the pie* is. Groundwater apportionment requires another step: deciding how large the *pie itself* is.

The Supreme Court should begin by determining the maximum pumping amount—the pie's size. This amount should be within the aquifer's sustainable

356. Mark Lubell et. al, *Sustainable Groundwater Management in California: A Grand Experiment in Environmental Governance*, 33 SOC'Y & NAT. RES. 1447, 1447 (2020); Basin Prioritization, *supra* note 93.

357. *See supra* Part I.B.

358. *See supra* Part II.E.

359. Kansas v. Nebraska, 574 U.S. 445, 455 (2015).

yield.[360] The apportionment's sustainable yield should ensure enough baseflow to groundwater dependent ecosystems to protect recreational uses, ecological systems, and surface appropriations. Any decree should reduce pumping to a level that prevents the worsening of adverse effects from over pumping, including overdraft, cones of depression, saltwater intrusion, and subsidence.

The Court should then decide how much of the sustainable yield each state gets—each state's slice of pie. The Court should decide each state's allocation of the total sustainable yield based on their relative contribution to the aquifer's recharge. This is proportional sustainable yield. If one state contributes 30 percent of the water to the aquifer, that state should be apportioned 30 percent of the sustainable yield.

Calculating proportional sustainable yield requires relatively precise knowledge of 1) each state's volume of vertical recharge into the aquifer, 2) how climate change will affect vertical recharge on a regional scale, 3) transboundary groundwater flows, and 4) the amount of outflow needed to support existing uses of surface waters.

Using models, such as the new CONUS model that breaks down recharge by square kilometer, hydrologists can determine the volume of water each state recharges into an aquifer on an average year.[361] While it would be more accurate to use a basin-specific model, creating such a model from scratch could delay the resolution of groundwater disputes, which are already lengthy affairs.[362] In the interest of expediency, the Court should use existing hydrologic models to determine vertical recharge rather than insisting on the creation of new models.

While it will be tempting to use high estimates of sustainable yield, the Court should prioritize using the most accurate estimates. The woes of the Colorado River Compact demonstrate the difficulty of using unrepresentatively high numbers to apportion water. The Colorado River Compact allocates more water than runs down the river each year.[363] The traditional explanation for this discrepancy is that the years leading up to the Compact were particularly wet.[364] When hydrologists based their estimates on flows from that period, the wet years gave them an incorrect sample of flows on an average year.[365] Taking a fresh

360. Specifically, the maximum pumping amount should be significantly less than the aquifer's maximum sustainable yield to leave room for uncertainty. Pierce et al., *supra* note 75, at 333–34.

361. The full model name is ParFlow-CLM CONUS 1.0. The ParFlow-CLM model couples hydrology and land surface features. Researchers applied the model to most of the continental United States, hence the CONUS. *See* O'Neill et al., *supra* note 83, at 7723–24.

362. *Mississippi v. Tennessee*, SCOTUSBLOG, https://www.scotusblog.com/case-files/cases/mississippi-v-tennessee/ (last visited June 11, 2023); *Florida v. Georgia*, SCOTUSBLOG, https://www.scotusblog.com/case-files/cases/florida-v-georgia-2/ (last visited June 11, 2023).

363. *See Colorado River Compact*, WATER EDUC. FOUND., https://www.watereducation.org/aquapedia-background/colorado-river-compact (last visited June 11, 2023); *Groundwater Flow to Colorado River May Decline by a Third over Next 30 Years*, USGS (2021), https://www.usgs.gov/news/state-news-release/groundwater-flow-colorado-river-may-decline-third-over-next-30-years#:~:text=A%20new%20study%20projects%20that,affecting%20both%20people%20and%20ecosystems.

364. MARK REISNER, CADILLAC DESERT 271 (1986).

365. *Id.*

look, historians Eric Kuhn and John Fleck show that decision makers *chose* to ignore the substantially lower, yet more accurate, estimates of a prominent U.S. Geological Survey hydrologist for the sake of political expediency.[366] The decision to use unrepresentative numbers has resulted in decades of litigation and confusion.[367] The Court should learn from the mistakes of the Colorado River Compact to use the most accurate estimates rather than the highest ones.

The most accurate estimates of sustainable yield must consider climate change.[368] Climate change will change precipitation amount, intensity, frequency, and evaporation plus evapotranspiration.[369] Modeling the interaction of climate change and groundwater recharge is relatively new, so substantial uncertainty still exists.[370] Models like CONUS could benefit from including climate estimates for the near future, rather than just incorporating retrospective climate data.[371] However, the Court must balance real-world accuracy with expediency. It may make more sense to use an existing retrospective model, like CONUS, to resolve a dispute more quickly, rather than waiting years for a more accurate model that incorporates climate change. If a more accurate model emerges, the Court could revisit apportionment decrees to incorporate it.

The Court should also factor in the net amount of groundwater that flows across state lines. Though groundwater moves slowly, the volume of water that moves across state lines can be substantial.[372] States overlying an interstate aquifer can both lose and gain water to and from neighboring states through underground flow.[373] In *Mississippi*, for example, the water flowed from Mississippi to Tennessee at a few inches per day.[374] Tennessee's proportional sustainable yield percentage should include the amount of horizontal flow that comes in from Mississippi in addition to the vertical recharge. If Tennessee lost any water to another state through underground flow, that volume would be subtracted from Tennessee's percentage.

366. ERIC KUHN & JOHN FLECK, SCIENCE BE DAMMED 77 (2019).

367. *See, e.g.*, Arizona v. California, 373 U.S. 546 (1963); Arizona v. California, 460 U.S. 605 (1983).

368. The Court recognized the need to address an unknowable and changed climate in *Nebraska*, where the Court apportioned the North Platte River after thirteen years of drought. *See* Nebraska v. Wyoming, 325 U.S. 598, 599. There, the Court based the apportionment on "dependable flow" rather than pre-drought, historic flow. *Id.* at 620.

369. *See, e.g.*, Rosana Nieto Ferreira et al., *Climate Change Effects on Summertime Precipitation Organization in the Southeast United States*, 214 ATMOSPHERIC RSCH. 348 (2018) (describing the effects of climate change on precipitation patterns in the U.S. southeast).

370. Brian D. Smerdon, *A Synopsis of Climate Change Effects on Groundwater Recharge*, 555 J. OF HYDROLOGY 125, 126 (2017). One study found that aquifers in the American Southwest and mountain west will experience less recharge with climate change, while aquifers in the north will see no change or a modest increase in recharge. Thomas Meixner et al., *Implications of Projected Climate Change for Groundwater Recharge in the Western United States*, 534 J. OF HYDROLOGY 124, 124 (2016).

371. O'Neill et al., *supra* note 83, at 7227.

372. *See* Mississippi v. Tennessee, 142 S. Ct. 31, 40 (2021).

373. WELCH ET AL. EDS., *supra* note 35 at 70–71.

374. *Mississippi v. Tennessee*, 595 U.S. at 25.

Unlike downstream states in surface water, down-aquifer states can influence the rate of water movement. As the *Mississippi* Court recognized, Memphis's pumping hastened the natural flow of water from Mississippi into Tennessee.[375] To the most accurate extent possible, the Court should determine transboundary flows using pre-pumping levels, rather than pumping-induced levels. Using pumping-induced levels would create a perverse incentive for states to try to hasten transboundary flow as much as possible before apportionment.

The Court should subtract the amount of water needed to satisfy existing surface water uses from each state's allotment. This calculation will likely be the most difficult and subjective aspect of determining proportional sustainable yield because there is a wide range of "acceptable" surface water flows. Preserving more surface water flows will benefit riparian ecosystems, surface water users, water-dependent recreation, and cultural traditions.[376] However, preserving more surface flow also decreases the amount of groundwater users can pump. The appropriate balance between surface water needs and groundwater user needs will differ depending on perspective. The Supreme Court can utilize flexibility when striking this balance.

Once the Court determines proportional sustainable yield, it needs to decide how long states have to achieve their appropriation. California's SGMA gave basins twenty years to achieve sustainable groundwater management.[377] On one hand, requiring quicker implementation for the biggest groundwater miners is desirable to prevent further degradation of the aquifer. On the other, giving groundwater miners more time can increase the thought, equity, and care put into achieving sustainable yield. The Court should determine the implementation timeline on a case-by-case basis.

B. A Hypothetical Groundwater Apportionment

Assume Arizona and New Mexico share an aquifer. The aquifer has been overdrafted, with Arizona pumping 180,000 acre-feet per year and New Mexico pumping 160,000 acre-feet per year. However, Arizona contributes less water to the aquifer. New Mexico sues Arizona for overusing the shared aquifer. The Supreme Court agrees to apportion the aquifer. The Special Master determines each state's vertical recharge, required surface flow, and transboundary flow. Combining these numbers, the Special Master determines that Arizona gets 50,000 acre-feet and New Mexico gets 150,000 acre-feet per year (see Table 1).

375. *Id.*
376. Gibson et al., *supra* note 55, at 28.
377. CAL. WATER CODE § 10727.2(b)(1) (West 2023).

Arizona would need to cut use in half, from 180,000 acre-feet to 90,000. New Mexico would need to cut use less, from 160,000 to 110,000.[378]

Table 1: Values Needed to Determine Proportional Sustainable Yield*

Parameter	Arizona	New Mexico
Vertical Recharge	100,000	180,000
Required Surface Flow	-30,000	-50,000
Natural Transboundary Flow (from New Mexico to Arizona)	+20,000	-20,000
Proportional Sustainable Yield	**90,000**	**110,000**
Current Use	180,000	160,000
Required reduction in use to meet proportional sustainable yield	**90,000**	**50,000**

*All units are in acre-feet.

If the Supreme Court feels it crucial to change the apportionment numbers due to existing uses, it can allow a state to draw up to, but never beyond, its maximum sustainable yield. Here, that means Arizona and New Mexico could draw up to 30,000 and 50,000 extra acre-feet, respectively. This is the amount the Special Master determined is required for surface flows. Doing so would greatly diminish any uses of that surface water but would make it easier for the states to achieve their apportionment.

C. Proportional Sustainable Yield Is Fair and Flexible

While the proportional sustainable yield test is substantively different than the surface water equitable apportionment test, it is consistent with the two animating concerns of that test: fairness and flexibility.

Dividing interstate aquifers with proportional sustainable yield is fair both between states and between generations. Since "equitable apportionment is directed at . . . preventing future injuries," it should consider future generations.[379] The fairest way to manage aquifers for future generations is to ensure their existence. Only an apportionment that uses sustainable yield will keep an interstate aquifer usable into the indefinite future. Future generations will be thankful that an aquifer exists to help them navigate the hotter, drier climate handed to them.

Between states, proportional sustainable yield is fairer than allowing continued extractive use. When one state overdrafts an interstate aquifer and

378. Using proportional sustainable yield may have the unwanted side effect of discouraging states from seeking judicial review. If all states are mining a shared aquifer, each state may see it is in their best interest to avoid judicial apportionment if they know that will result in their reduction of water abstractions as well. Attorneys general may be hesitant to "win" in court, bringing home a decree that requires water users to decrease usage.

379. *See* Idaho ex rel. Evans v. Oregon, 462 U.S. 1017, 1028 (1983).

changes transboundary flow, users in the overdrafting state unfairly take water from neighboring states. Requiring each state to match their pumping to their recharge amount will prevent the worst types of spillover effects because each state will be operating within its own natural bounty rather than syphoning water from neighboring states.[380]

Dividing interstate aquifers with proportional sustainable yield leaves some room for flexibility, albeit less than the surface water test. The Court has flexibility in determining whether to apportion water closer to permissive or maximum sustainable yield, which can be a big difference.[381] The Court also has flexibility in deciding how long individual states have to reach sustainable yield.

While the proportional sustainable yield test differs from the surface water test, it fits snugly within the policy goals that created the surface water test.

CONCLUSION

Since interstate groundwater allocation is largely uncharted territory, we must learn from prior water problems to create effective management. Mono Lake's depletion, Cape Town's Day Zero, and the Colorado River Compact give us lessons of how not to manage groundwater. The Colorado River Compact teaches us that we shouldn't take the politically easy option when we know that option is based on inaccurate science. Cape Town teaches us we shouldn't be blind to the problem and ignore warnings. Mono Lake teaches us that we shouldn't wait.

Though the Supreme Court held that equitable apportionment applies to interstate groundwater in *Mississippi*, it is unlikely to judicially apportion waters, and even more unlikely to use sustainable yield as its guiding principle when doing so.[382] In the absence of judicial apportionment, Congress should think creatively about how to incentivize the creation of interstate compacts which achieve sustainable yield.

Transitioning towards sustainable yield will disrupt entire communities, livelihoods, and cultures. But the reality is, those cultures and communities will be disrupted with the status quo as well. It's just that the status quo puts that disruption on future generations—future generations who will already bear the unfair burden of adapting to a drastically changed climate. If policymakers took responsibility for groundwater overdraft, as California's legislature did with SGMA, it would ensure that future generations will *at least* have groundwater to rely on when the climate is hotter and less predictable.

While this Note focuses on the Supreme Court and interstate compacts, state-wide and local groundwater legislation is also vital. Whether the reader be

380. Proportional sustainable yield is not the fairest way to divide an interstate aquifer; it is the fairest way the *Supreme Court* can divide an interstate aquifer using its limited original jurisdiction. The Supreme Court likely cannot exercise the important conditions explained in Subpart C within Part III.

381. *See* Pierce et al., *supra* note 75, at 333–34.

382. Mississippi v. Tennessee, 141 S. Ct. 31 (2021).

a water manager, judge, farmer, legislator, lawyer, or activist, my hope is that the reader feels a new sense of urgency around interstate groundwater management and takes that sense of urgency to help better manage our aquifers.