# New Water for Water Dispute Resolution

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*Water scarcity often leads to water disputes. New water supplies—such as bulk water imports, desalination, cloud seeding, or increased stream flows from improved forest management—can mitigate water scarcity and thus help avoid water disputes. However, new water supplies can also aggravate water disputes if not developed in concert with legal reforms. This Article evaluates the role of new water in two cases of water disputes in arid regions and proposes legal reforms to promote new water as a means of water dispute resolution. The first case is the adjudication of water rights in the Gila River basin in Arizona. Improved forestry management could increase water supplies and help resolve this decades-old dispute, but Arizona law should reconsider how property rights are assigned to such increased supplies and what legal mechanisms could encourage investment in forestry management. The second case involved disputes over water resources in refugee host communities in Lebanon and Jordan. The influx of Syrian refugees into cities in Lebanon and Jordan can give rise to water disputes. Laws in the countries can be reformed to facilitate water augmentation and thereby provide increased supplies to refugee host communities.*

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## INTRODUCTION

I am the father of four children. As such, I have a maddening amount of experience in mediating and adjudicating resource allocation disputes—ranging from cookies to TV viewing choice. I would love to brag about my successes in teaching my children about sharing and selflessness. But too frequently, my approach to these resource allocation disputes is often to simply grow the pie rather than split it more equitably (in some cases, this means a literal pie). I buy the extra cookie instead of having them share, and I extend their bed times to accommodate everyone's desire to watch their preferred TV show, rather than helping them reach a compromise.

I am currently working on two challenging projects involving resource allocation disputes that, while far more serious and significant than any family disagreement, spur a familiar "grow the pie" impulse. The first project is part of my work as a Senior Research Fellow with the Kyl Center for Water Policy at the Morrison Institute for Public Policy, where I work as part of a team attempting to reform the state of Arizona's General Stream Adjudications ("GSAs").[1] The GSAs are large-scale water rights adjudications implicating nearly every non-Colorado River surface water right in the state.[2] The GSAs have languished for over forty years with no end in sight, and the uncertainty surrounding ownership of water rights—and the priorities and quantities of those rights—stifles potential water markets and limits long-term water planning in the state.[3] While there are many reasons for the intractable status of the GSAs, one aggravating factor is the scarcity of water in Arizona's arid Sonoran Desert.[4] Thus, one potential mitigating approach is to "grow the pie" by increasing water supplies through desalination, water recycling, or improved watershed management.

The second project involves my work as the principal investigator for a $1.94 applied research grant from the U.S. Agency for International Development ("USAID") to address water insecurity in the Middle East.[5] The project involves a holistic approach to water development in refugee host communities in Lebanon and Jordan.[6] Lebanon and Jordan—already strained by hosting large populations of

1. For an overview of Arizona's general stream adjudications, see generally Joseph M. Feller, *The Adjudication that Ate Arizona Water Law*, 49 ARIZ. L. REV. 405 (2007).

2. *Id.*; *see also* Rhett Larson & Kelly Kennedy, *Bankrupt Rivers*, 49 U.C. DAVIS L. REV. 1335, 1348–56 (2016).

3. Larson & Kennedy, *supra* note 2, at 1348–49.

4. *Id.* at 1339–40.

5. Jason Franz, *ASU and Partners to Bring Clean Water to Middle East Communities*, ASU NOW (Jan. 12, 2017), https://asunow.asu.edu/20170111-arizona-state-university-and-partners-bring-clean-water-middle-east-communities [https://perma.cc/X6ZT-RQLP].

6. *Id.*

Iraqi and Palestinian refugees—have born the greatest burden of absorbing the Syrian refugee population.[7] This growing refugee community in already water-scarce cities and towns has the potential to result in water disputes between refugees and their hosts. The USAID project aims to avoid or alleviate such disputes by "growing the pie"—increasing available water supplies through treatment of otherwise unusable brackish groundwater and augmenting supplies through an innovative new technology that generates drinking water from water vapor in the air.

The problem of water scarcity and resulting disputes are not unique to these two cases. Indeed, more severe drought conditions caused by global climate change, along with growing populations and increased consumption, make water scarcity and its resulting implications for human conflict a global challenge.[8] Of course, cooperation, compromise, and conservation are essential to respond to this global challenge, and "grow the pie" water strategies can make only so much progress absent strong "share the pie" water policies.[9] Indeed, the three priorities of water policy should be first, to understand the water we have; second, to better conserve and protect the water we have; and third, if necessary and cost-effective, increase the water supply.[10] This Article discusses this third priority in the context of the two projects discussed above, arguing that innovations in policy and technology can facilitate water supply augmentation for the purpose of water dispute resolution.

This Article proceeds in three Sections. Section I briefly describes the water challenges involved in Arizona's GSAs and refugee host communities in Jordan and Lebanon. Section II discusses how innovations in technology and water management can help address these water challenges by increasing the available water supply and evaluating the costs and benefits of such innovations. Section III proposes legal reforms to promote water supply augmentation in each of these projects.

7. Laurie A. Brand & Marc Lynch, *How the Refugee Crisis is Transforming the Middle East*, THE WASH. POST (Mar. 30, 2017), https://www.washingtonpost.com/news/monkey-cage/wp/2017/03/30/how-the-refugee-crisis-is-transforming-the-middle-east/?utm_term=.98c2b0cddd52 [https://perma.cc/B4ZU-CD32].

8. Rhett B. Larson, *Reconciling Energy and Food Security*, 48 U. RICH. L. REV. 929, 930–32 (2014).

9. *See generally* Barton H. Thompson, *Institutional Perspectives on Water Policy and Markets*, 81 CAL. L. REV. 671 (1993) (broadly discussing the need for conservation incentives and improved water governance to manage water demand in arid regions).

10. Rhett B. Larson, *Augmented Water Law*, 48 TEX. TECH L. REV. 757, 778 (2016).

## I. THE NEED FOR NEW WATER IN THE MIDDLE EAST AND ARIZONA

The combination of climate change, population growth, and increasing consumption patterns in many arid regions may make water conservation strategies a necessary but insufficient approach to addressing water scarcity.[11] In some cases, regions may not be able to conserve their way out of the challenge of water scarcity and may have no other option but to augment their water supplies.[12] This Section briefly describes the development and current status of four possible approaches to water augmentation and evaluates their respective costs and benefits.

### A. *Arizona's General Stream Adjudications*

Similar to most states in the western U.S., Arizona allocates water rights based on the doctrine of prior appropriation.[13] Under this "first in time, first in right" doctrine, the state allocates the relative priority of water rights based on the date a user first puts a specified amount of water to beneficial use.[14] Under the doctrine of prior appropriation, when surface water flows are insufficient to satisfy the quantities allocated to all right-holders, a senior right-holder may place a "call on the river."[15] The call requires junior right-holders, with later priority dates, to stop diverting until the senior's water right is satisfied.[16] Taking water out of priority interferes with a vested water right, and is subject to call. However, under the "futile call doctrine" a state will decline to cut off a junior right-holder if the water would not reach the senior right-holder downstream regardless of the junior's forbearance.[17]

The beneficial use, diversion point, quantity of water, and relative priority date of each water right can be difficult to establish with certainty in many cases.[18] There are five reasons for this difficulty in es-

11. Patricia Wouters et al., *Water Security, Hydrosolidarity, and International Law: A River Runs Through It . . .* , 19 Y.B. INT'L ENVTL. L. 97, 98 n.6 (2009).

12. A. Dan Tarlock, *Takings, Water Rights, and Climate Change*, 36 VT. L. REV. 731, 750 (2012).

13. Peter L. Reich, *The "Hispanic" Roots of Prior Appropriation in Arizona*, 27 ARIZ. ST. L.J. 649, 649 (1995).

14. Alexandra B. Klass, *Property Rights on the New Frontier: Climate Change, Natural Resource Development, and Renewable Energy*, 38 ECOLOGY L.Q. 63, 86 (2011).

15. Brian E. Gray, *No Holier Temples: Protecting the National Parks Through Wild and Scenic River Designation*, 58 U. COLO. L. REV. 551, 579 (1988).

16. *Id.*; *see also* Eli Feldman, *Death Penalty for Water Thieves*, 8 U. DENV. WATER L. REV. 1, 3 (2004).

17. A. Dan Tarlock, *The Law of Equitable Apportionment Revisited, Updated, and Restated*, 56 U. COLO. L. REV. 381, 406 (1985).

18. Michael McIntire, *The Disparity Between State Water Rights Records and Actual Water Use Patterns: "I Wonder Where the Water Went?"*, 5 LAND & WATER L. REV. 23, 25 (1970).

tablishing a predictable and certain water rights regime in Arizona. First, in the early years following statehood, anyone could claim a prior appropriation right in Arizona simply by intending to divert water, actually diverting the water, and then putting the water to a beneficial use.[19] It was not until 1919 that diverters were required to file notices of intent with the state and receive certificates of water rights.[20] As such, many of the earliest and thus highest priority water rights in Arizona lack reliable documentation, both because of the paperless nature of many pre-1919 rights and because of limited funding for the agency responsible to maintain water rights records—the Arizona Department of Water Resources ("ADWR").[21]

Second, the priority date of a given water right relates back to the date of the filing of the notice of intent or to the date the diversion project first began for rights dating before 1919, as long as the water appropriator was diligent in completing the diversion project.[22] For example, imagine a farmer filed a notice of intent with ADWR to divert water on December 1, 1941, and immediately began to dig a ditch to divert water to irrigate his farm. Shortly thereafter, the farmer is drafted into the military and leaves his farm for three years. During those three years, several others file notices of intent and divert water. Has the soldier-farmer lost his 1941 priority date, or does his right "relate back" to that original filing? His priority date is the original 1941 filing date if he is considered to have been diligent during those three years at war. Determining diligence and "relation back" are difficult, nuanced inquiries and introduce another degree of uncertainty regarding the status of Arizona surface water rights.[23]

Third, a water right holder might lose their priority date and their water right entirely through forfeiture.[24] In Arizona, the failure to use surface water for five years results in loss of the water right.[25] The principle of forfeiture encourages the use and development of a water right, but also can discourage conservation and efficiency out of a con-

19. Larson & Kennedy, *supra* note 2, at 1350; *see also* Sean E. O'Day, San Carlos Apache Tribe v. Superior Court*: Rejecting Legislative Favoritism in Water Rights Allocations*, 4 U. DENV. WATER L. REV. 29, 35 (2000).

20. Larson & Kennedy, *supra* note 2, at 1350; O'Day, *supra* note 19, at 49–51.

21. Larson & Kennedy, *supra* note 2, at 1345; O'Day, *supra* note 19, at 50; *see also* Kathleen Ferris, *Like Water? Then Don't Leave Agency in a Drought*, USA TODAY: AZ. CENTRAL (Jan. 25, 2015), http://www.azcentral.com/story/opinion/op-ed/2015/01/25/arizona-department-water-resources-funding/22250083/ [https://perma.cc/VL9U-4VKV].

22. Dennett L. Hutchinson, *Determining Priority of Federal Reserved Rights*, 48 U. COLO. L. REV. 547, 554 (1977).

23. *See* Barton H. Thompson, Jr., *Uncertainty and Markets in Water Resources*, 36 MCGEORGE L. REV. 117, 118 (2005).

24. *See generally* Janet C. Neuman & Keither Hirokawa, *How Good is an Old Water Right? The Application of Statutory Forfeiture Provisions to Pre-Code Water Rights*, 4 U. DENV. WATER L. REV. 1, 2–3 (2000) ("A central tenet of the prior appropriation system is 'use it or lose it.'").

25. *Id.* at 14.

cern that water saved will result in a water right being forfeited.[26] The risk of forfeiture adds another layer of complexity and uncertainty to the determination of water rights in Arizona.[27]

Fourth, under Arizona's 1919 surface water code, water rights in Arizona must put water to a beneficial use, without waste. Beneficial use is the "basis, measure and limit to the use of the water in the state."[28] Beneficial use includes domestic, municipal, irrigation, stock watering, recreation, wildlife, water storage, and mining uses.[29] As such, in attempting to establish a clear, predictable water rights regime, Arizona seeks to permit competing users can claim that another water use is not beneficial or is otherwise wasteful.

Fifth, surface water rights held by Native American tribes and reservations of federal land (like national parks or wildlife refuges) are clearly established in this prior appropriation framework, but not clearly quantified.[30] Native American tribal land and land owned by the U.S. federal government comprise an enormous percentage of western lands.[31] When the U.S. federal government reserves land for any reason, including national parks or tribal reservations, it implicitly reserves the minimum amount of water necessary to meet the primary purpose of that reservation.[32] These rights are called federally-reserved rights or *Winters* rights, after the U.S. Supreme Court decision in *Winters v. United States* establishing the doctrine.[33] The "primary purpose" of Indian reservations is to establish a permanent homeland.[34] To quantify the minimum amount of water necessary to achieve that purpose, courts have generally used the tribal reservation's practicably irrigable acreage ("PIA").[35] However, as part of the GSA, the Arizona Supreme Court considered alternative factors

26. Sharon Megdal et al., *The Forgotten Sector: Arizona Water Law and the Environment*, 1 ARIZ. J. ENVTL. L. & POL'Y 243, 289 (2011).

27. Janet C. Neuman, *Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use*, 28 ENVTL. L. 919, 928–29 (1998).

28. ARIZ. REV. STAT. ANN. § 45-141(B), *held unconstitutional by* San Carlos Apache Tribe v. Superior Court ex rel. Cty. of Maricopa, 972 P.2d 179 (Ariz. 1999).

29. § 45-151(A), *held unconstitutional by* San Carlos Apache Tribe v. Superior Court ex rel. Cty. of Maricopa, 972 P.2d 179 (Ariz. 1999).

30. Kobi Webb, *Federal vs. State Authority to Regulate Groundwater: Concerns Raised over U.S. Forest Service Proposed Directive*, 19 U. DENV. WATER L. REV. 297, 301 (2016).

31. CONG. RESEARCH SERV., FEDERAL LAND OWNERSHIP: OVERVIEW AND DATA 18–21 (2012), http://fas.org:8080/sgp/crs/misc/R42346.pdf [https://perma.cc/QEQ6-WMPM]; *see also* U.S. DEP'T OF AGRIC., ECON. RESEARCH SERV.: MAJOR USES OF LAND IN THE UNITED STATES 35–36 (2002).

32. Arizona v. California, 373 U.S. 546, 601 (1963); Winters v. United States, 207 U.S. 564, 577 (1908); Cappaert v. United States, 426 U.S. 128, 141 (1976); *see also* United States v. New Mexico, 438 U.S. 696, 718 (1978).

33. *Winters*, 207 U.S. at 577–78.

34. *Id.* at 576–77.

35. *Arizona*, 373 U.S. at 600–01. Included in calculating the PIA are total acreage, arability of the land, and engineering and economic feasibility. *In re* Gen. Adjudication of All Rights to Use Water in the Big Horn River Sys., 753 P.2d 76, 101 (Wyo.

rather than PIA in quantifying tribal water rights, including tribal culture, population, and water use plans.[36]

This more nuanced approach has certain potential advantages over PIA, but still generates significant uncertainties about how much water can ultimately be claimed by tribes.[37] There is even more uncertainty regarding other federal reservations—unlike national parks or wildlife refuges, there is at least some history of tribal water rights settlements and quantifications to guide how Native American *Winters* rights will be quantified.[38] There is little guidance about the minimum amount of water necessary to meet the primary purpose of a reservation like the Grand Canyon or Yellowstone.[39] These federally-reserved rights generally fit within the prior appropriation regimes of western states. The priority dates for *Winters* rights are time immemorial for reserved aboriginal tribal lands[40] or the date the reservation was established for other reservations.[41]

The complexity created by the lack of adequate documentation for many senior priority rights, the diligence requirement for priority to relate back to the original filing, the possibility of a right being lost to forfeiture or a claim of waste or lack of a beneficial use, and the difficulty in quantifying federally-reserved rights, makes establishing a clear picture of water rights in Arizona a daunting task—one left to the courts in the GSA process.[42] As Arizona's population grows and climate change induces more frequent and severe droughts in the southwestern U.S., the need to resolve the legal disputes between water users in Arizona—typified by and largely integrated within the GSAs—becomes more and more pronounced.[43]

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1988), *aff'd by an equally divided court,* Wyoming v. United States, 492 U.S. 406 (1989).

36. *In re* Gen. Adjudication of All Rights to Use Water in the Gila River Sys. & Source, 35 P.3d 68, 78–80 (Ariz. 2001).

37. Robert T. Anderson, *Indian Water Rights and the Federal Trust Responsibility*, 46 NAT. RESOURCES J. 399, 427–30 (2006).

38. Barbara A. Cosens, *The Measure of Indian Water Rights: The Arizona Homeland Standard, Gila River Adjudication*, 42 NAT. RESOURCES J. 835, 865 (2002).

39. Wendy Weiss, *The Federal Government's Pursuit of Instream Flow Water Rights*, 1 U. DENV. WATER L. REV. 151, 160–63 (1998).

40. United States v. Adair, 723 F.2d 1394, 1414 (9th Cir. 1983).

41. Cappaert v. United States, 426 U.S. 128, 138 (1976).

42. ALASKA STAT. § 46.15.065 (2016); ARIZ. REV. STAT. ANN. §§ 45-251 to -264 (2016); CAL. WATER CODE §§ 2000 to 2900 (West 2016); COLO REV. STAT. §§ 37-92-101 to -602 (2016); IDAHO CODE §§ 42-1401 to -1428 (2016); MONT. CODE ANN. §§ 85-2-201 to -243 (2015); NEB. REV. STAT. §§ 46-226 to -231 (2016); NEV. REV. STAT. ANN. §§ 533.090 to .320, 534.100 (West 2015); N.M. STAT. ANN. §§ 72-4-13 to -19 (West 2016); N.D. CENT. CODE §§ 61-03-15 to -20 (2016); OKLA. STAT. ANN. tit. 82, §§ 105.6 to .8 (West 2016); OR. REV. STAT. §§ 539.010 to .350, 541.310 to .320 (2016); S.D. CODIFIED LAWS §§ 46-10-1 to -13 (2016); TEX. WATER CODE ANN. §§ 11.301 to .341 (West 2015); UTAH CODE ANN. §§ 73-4-1 to -24 (West 2016); WASH. REV. CODE §§ 90.03.110 to .245 (2016); WYO. STAT. ANN. §§ 41.4.301 to .331 (2016).

43. *See* Holly Doremus & A. Dan Tarlock, *Fish, Farms, and the Clash of Cultures in the Klamath Basin*, 30 ECOLOGY L.Q. 279, 285–86 (2003).

Before the advent of the GSA process, most water rights disputes in Arizona involved two-party suits for injunctive relief or suits for damages against those taking water out of priority, effectively the straightforward "call on the river."[44] However, courts needed to adopt unique procedures as these cases increasingly involved a growing number of parties over a larger area.[45] The goal of the courts in such cases was to "definitely award the respective rights to the parties to the action," but the courts' decrees often lacked finality and specificity, in large part because critical parties were not involved in the proceedings, including those holding *Winters* rights.[46]

In 1952, the U.S. Congress enacted the McCarran Amendment, which waived the federal government's sovereign immunity in state water rights proceedings that were deemed comprehensive over a whole water basin.[47] Effectively, this meant that federal *Winters* rights holders—including federal agencies managing national parks and sovereign Native American tribes—could be required to adjudicate their water rights in state courts, so long as the state proceeding integrated all of the water right holders and their respective issues over an entire river system.[48] This legislation encouraged states to enact broad, inclusive procedures for adjudication of many water rights claims over large areas. In short, the legislation established general stream adjudications.[49]

As would be anticipated for a process involving so many parties over a large area, GSAs are time-consuming and resource-intensive.[50] Arizona's Gila River GSA illustrates just how difficult and costly this process can be for resolving water rights disputes. The early legal disputes in the Gila River basin began before Arizona was a state.[51] The Gila River GSA officially commenced legislation and court filings in 1976, and after over forty years, the legal dispute has still not been

44. Larson & Kennedy, *supra* note 2, at 1345.

45. *Id.*

46. *Id.* (citation omitted); *see generally* Stephen M. Feldman, *The Supreme Court's New Sovereign Immunity Doctrine and the McCarran Amendment: Toward Ending State Adjudication of Indian Water Rights*, 18 HARV. ENVTL. L. REV. 433 (1994).

47. 43 U.S.C.S § 666 (2012); *see generally* Aubri Goldsby, *The McCarran Amendment and Groundwater: Why Washington State Should Require Inclusion of Groundwater in General Stream Adjudications Involving Federal Reserved Water Rights*, 86 WASH. L. REV. 185 (2011).

48. Goldsby, *supra* note 47, at 186; Reed D. Benson, *Deflating the Deference Myth: National Interests vs. State Authority under Federal Laws Affecting Water Use*, 2006 UTAH L. REV. 241, 268–69 (2006).

49. Scott B. McElroy & Jeff J. Davis, *Revisiting* Colorado River Water Conservation District v. United States—*There Must Be a Better Way*, 27 ARIZ. ST. L.J. 597, 642 (1995).

50. Larson & Kennedy, *supra* note 2, at 1347–48.

51. *See, e.g.*, Hurley v. Abbott (*Kent Decree*), Arizona Territorial Court, No. 4564 (Mar. 1, 1910) (slip opinion reprinted and published by the Salt River Valley Water Users Association).

resolved or made meaningful progress toward resolution.[52] The obstacles to the resolution of the GSA include the reasons discussed above, including quantification of *Winters* rights, uncertainty regarding priority, forfeiture, or beneficial use, and the lack of adequate documentation and agency funding. However, additional factors further aggravate the GSA process beyond the normal obstacles facing the adjudication of water rights generally in prior appropriation regimes.

First, the sheer number of parties involved and the geographic scope of their claims makes resolution of the GSA extremely difficult. Today, the Gila River GSA includes over 38,000 parties with nearly 100,000 claims.[53] The Gila River stretches over 600 miles across Arizona, and is the second largest river in Arizona, second only to the Colorado river.[54] The Gila River begins in New Mexico, extends west through the Gila River Indian Community and the Phoenix metropolitan area, and then southwest where it joins the Colorado River.[55] The river drains water from nearly 60,000 square miles, totaling half the land in the state.[56] Almost every major river in Arizona flows into the Gila, including large tributaries like the San Pedro River, Salt River, and Verde River. About 20% of the water used in Arizona is from the Gila River and its tributaries.[57]

The second aggravating factor preventing resolution of the GSA is the issue of subflow and the bifurcated nature of Arizona's water rights regime. Arizona's GSAs apply only to surface water rights.[58] Arizona has a bifurcated water rights system under which surface water is governed largely by prior appropriation, and groundwater operates under an entirely different set of rules.[59] This legal distinction between surface water and groundwater determines not only what rules apply to a water right, but also whether or not a right is subject to adjudication by the GSA court.[60] But there is no way to draw a clear and easily agreed-upon hydrologic line between surface water

52. Larson & Kennedy, *supra* note 2, at 1348.

53. *Id.*; *see also General Description of Adjudications Program*, ARIZ. DEP'T WATER RES., http://www.azwater.gov/AzDWR/SurfaceWater/Adjudications/ [https://perma.cc/VT3K-4XLR] (last updated May 31, 2017).

54. *See* JIM TURNER, ARIZONA: A CELEBRATION OF THE GRAND CANYON STATE 43 (2011).

55. Larson & Kennedy, *supra* note 2, at 1349.

56. *River of the Month Series: August 2012 the Gila River*, ENVTL. DEF. FUND (2012), http://www.edf.org/sites/default/files/GilaRiverFactSheet.pdf [https://perma.cc/Q34G-BVDD].

57. Feller, *supra* note 1, at 409.

58. Larson & Kennedy, *supra* note 2, at 1342.

59. *Id.* at 1342 nn.32–33. For an overview of Arizona's complex groundwater law, see generally Rita Pearson Maguire, *Patching the Holes in the Bucket: Safe Yield and the Future of Water Management in Arizona*, 49 ARIZ. L. REV. 361 (2007).

60. For an overview of the importance and complexity of the subflow question, see generally Robert J. Glennon & Thomas Maddock, III, *In Search of Subflow: Arizona's Futile Effort to Separate Groundwater from Surface Water*, 36 ARIZ. L. REV. 567 (1994).

and groundwater.[61] A shallow well drilled near a river may mostly be pumping water directly from the river. A deep well located far from the river may mostly be pumping water from a deep aquifer with limited impact on the overlying stream. Water pumped from the surface water source must have a priority date and be adjudicated as part of the GSA. Water that is underground but more closely associated with the surface and thus subject to prior appropriation and the GSA is called *subflow*.[62]

In an interlocutory appeal in the Gila River GSA, the Arizona Supreme Court addressed the long-standing subflow question, defining *subflow* as waters residing in the "saturated floodplain Holocene alluvium."[63] Water pumped from this hazily-defined area immediately beneath the surface is subject to the GSA, and water beneath that subflow zone is not subject to the GSA. But the line is impossible to draw perfectly, in part because even a well pumping outside of that area may have a cone of depression that extends into the subflow zone.[64]

To progress toward resolving the GSA, reforms are required to address the subflow issue while finding a way to decrease the transaction costs associated with a proceeding that includes thousands of parties. But perhaps an additional approach to resolving the GSA is to increase the water supply within the basin.

### B. *Water and Refugees in Jordan and Lebanon*

As with the GSAs in Arizona, water disputes in Lebanon and Jordan arise in part from a growing population in an arid region, and thus, an augmented water supply presents a possible approach to avoiding or mitigating water disputes. Unlike the Arizona GSAs, however, the socio-cultural and geopolitical significance of the current source of much of the population growth—the ongoing Syrian refugee crisis—presents unique water challenges for communities hosting refugees.[65] This humanitarian crisis is of such a magnitude that it wholly eclipses any concerns associated with the Arizona GSAs.[66] And yet,

61. *Id.* at 570–74.

62. *See* Robert J. Glennon & Thomas Maddock, III, *In Search of Subflow: Arizona's Futile Effort to Separate Groundwater from Surface Water*, 36 ARIZ. L. REV. 567, 570–71 (1994).

63. *In re* Gen. Adjudication of All Rights to Use Water in Gila River Sys. & Source, 9 P.3d 1069, 1073 (Ariz. 2000) (commonly referred to as *Gila River IV*).

64. *Id.* at 1073–82.

65. Nicholas Burns & David Miliband, Opinion, *Syria's Worsening Refugee Crisis Demands Action from the West*, THE WASH. POST (July 9, 2015), https://www.washingtonpost.com/opinions/syrias-worsening-refugee-crisis/2015/07/09/88a6baa0-24a6-11e5-b77f-eb13a215f593_story.html?utm_term=.903cbafa5a94 [https://perma.cc/R2AQ-UQWK].

66. *See* Griff Witte, *New U.N. Report Says World's Refugee Crisis is Worse than Anyone Expected*, THE WASH. POST (June 18, 2015), https://www.washingtonpost.com/world/europe/new-un-report-says-worlds-refugee-crisis-is-worse-than-anyone-expect

because both present challenges associated with water management, both hold lessons for how law might be reformed to encourage investment in water supply augmentation.

The ongoing civil war in Syria has resulted in the most serious refugee crisis since World War II.[67] The two countries that have born among the greatest burdens of absorbing Syrian refugees are two of Syria's neighbors—Jordan and Lebanon.[68] As of early 2017, over one million Syrian refugees reside in Lebanon and over 600,000 in Jordan.[69] One in every four people in Lebanon is a Syrian refugee, and one in every eight people in Jordan is a Syrian refugee.[70] While U.N. refugee camps in Jordan absorb a certain number of Syrians fleeing conflict, there are no such formal refugee camps in Lebanon, and most Syrian refugees in both countries do not settle in camps, but in cities and towns amongst Jordanians and Lebanese citizens.[71]

This influx of refugees places an enormous strain on host communities in Lebanon and Jordan and, in some instances, has resulted in tensions between refugees and their hosts.[72] Both countries were already struggling with economic challenges, with annual GDP growth dropping from 8.5% to 1.4% in Lebanon and from 5.5% to 2.7% in Jordan between 2009 and 2012.[73] Most Syrian refugees in Jordan have settled in the country's most densely populated governorates—Amman, Irbid, and Zarqa—where 57% of Jordanians already live below the poverty line.[74] In Lebanon, 60% of Syrian refugees have settled in the north or in the Beka'a Valley—the two poorest regions in Lebanon.[75]

Perhaps even more significant than this general economic strain, the refugee crisis imposes an enormous strain on an already difficult water

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ed/2015/06/17/a49c3fc0-14ff-11e5-8457-4b431bf7ed4c_story.html?utm_term=.8da693973971 [https://perma.cc/78ZY-46B2].

67. Patrick Boehler & Sergio Peçanha, *The Global Refugee Crisis, Region by Region*, N.Y. TIMES (Aug. 26, 2015), https://www.nytimes.com/interactive/2015/06/09/world/migrants-global-refugee-crisis-mediterranean-ukraine-syria-rohingya-malaysia-iraq.html.

68. *See* Deidre McPhillips, *The Tragic Numbers Behind Syria's Refugees*, U.S. NEWS (Dec. 19, 2016), https://www.usnews.com/news/best-countries/articles/2016-12-19/countries-hosting-the-highest-proportion-of-syrian-refugees [https://perma.cc/349M-P8M7].

69. *Id.*

70. *Id.*

71. Lara Saade & Cynthia Delgadillo, *Syrian Refugees Living in Jordan and Lebanon: Young, Female, at Risk*, WORLD BANK (Dec. 16, 2015), http://www.worldbank.org/en/news/press-release/2015/12/16/syrian-refugees-living-in-jordan-and-lebanon-caught-in-poverty-trap [https://perma.cc/8FQY-33LU].

72. Omar Dahi, *The Refugee Crisis in Lebanon and Jordan: The Need for Economic Development Spending*, 47 FORCED MIGRATION REV. 11 (Sept. 2014).

73. *Id.*

74. *Id.*

75. *Id.* at 12.

management situation in both Lebanon and Jordan.[76] Both Lebanon and Jordan fall below the water poverty line.[77] In Jordan, Syrian refugees have increased total water consumption by 5.5% since 2012, a significant increase over such a short time and in such an arid country.[78] In Lebanon, groundwater abstraction in some regions has increased due to the influx of refugees to the point of drying up wells, resulting in many Syrian refugees in Lebanon living on less than two gallons of clean water each day.[79] The presence of Syrian refugees, and the strain their presence places on already limited water resources, has caused tensions between refugees and host communities in both Lebanon and Jordan.[80]

In Shatila, a refugee-host community in Lebanon, over pumping and deepening of wells has resulted in withdrawals of highly brackish groundwater that is not potable.[81] In Jordan, refugee-host communities are similarly facing challenges with strains on available water resources, resulting in attempts to rely on groundwater with high salinity levels.[82] If these brackish groundwater sources could be cost-effectively treated to potable standards, they may be the key to injecting a sufficient supply of clean water to alleviate tensions between Syrian refugees and their host communities in Lebanon and Jordan.

76. *See* Mohamed F. Hamoda, *Water Strategies and Potential Water Reuse in the South Mediterranean Countries*, 165 DESALINATION 31 (2004).

77. Hatem Jemmali & Caroline A. Sullivan, *Multidimensional Analysis of Water Poverty in MENA Region: An Empirical Comparison with Physical Indicators*, 115 SOC. INDICATORS RES. 253, 277 (2014); Eran Feitelson & Jonathan Chenoweth, *Water Poverty: Towards a Meaningful Indicator*, 4 WATER POL'Y 263, 271 (2002).

78. Aleena Farishta, *The Impact of Syrian Refugees on Jordan's Water Resources and Water Management Planning* (May 2014) (unpublished M.S. thesis) (on file with the Columbia University Academic Commons), https://academiccommons.columbia.edu/catalog/ac:175300.

79. Stephen J. Klingseis, *Syrian Refugees: Are they a Non-Traditional Threat to water Supplies in Lebanon and Jordan?* (Sept. 2016) (unpublished M.A. thesis) (on file with the Naval Post Graduate School), https://www.hsdl.org/?view&did=796642.

80. Taylor Luck, *In Jordan, Tensions Rise Between Syrian Refugees and Host Community*, THE WASH. POST (Apr. 21, 2013), https://www.washingtonpost.com/world/middle_east/in-jordan-tensions-rise-between-syrian-refugees-and-host-community/2013/04/21/d4f5fa24-a762-11e2-a8e2-5b98cb59187f_story.html?utm_term=.61a0b211f3f0 [https://perma.cc/KA6F-AMGD]; Tim Midgley, Johan Eldebo, Amir Amarani & Nadene Robertson, *Under Pressure: The Impact of the Syrian Refugee Crisis on Host Communities in Lebanon*, WORLD VISION INT'L (July 12, 2013), http://wvi.org/europe/publication/under-pressure-impact-syrian-refugee-crisis-host-communities-lebanon [https://perma.cc/DR5R-PD4M].

81. Peter Schwartzstein, *Syrian Refugees in Lebanon Camp Reliant on 'Hell Water' that Reduces Metal to Rust*, THE GUARDIAN (May 26, 2015), https://www.theguardian.com/global-development/2015/may/26/syrian-refugees-lebanon-shatila-camp-hell-water [https://perma.cc/Y9J7-2W7F].

82. Khaled A. Alqadi & Lalit Kumar, *Water Policy in Jordan*, 30 INT'L J. WATER RES. DEV. 322, 323 (2013).

## II. NEW WATER SOURCES FOR WATER DISPUTE RESOLUTION

The water disputes between users involved in Arizona's GSAs and between refugees and their host communities in Lebanon and Jordan could certainly benefit from improved water conservation and management and from governance reforms that facilitate collaboration and dispute resolution. These are complex problems requiring multiple, adaptive solutions. This Section proposes solutions based on water supply augmentation in both the Arizona GSA context and the refugee host community context.

### A. *New Water and the Arizona General Stream Adjudications*

There are several potential sources of augmented water supplies to help alleviate water scarcity and thereby facilitate resolution of the GSAs. But many of these sources come at a high cost and with a fairly high degree of uncertainty and controversy. Arizona could support sea water desalination in Mexico, or California could increase water supplies there in exchange for a transfer of water rights from those jurisdictions to Arizona on the Colorado River.[83] But such an arrangement would have significant political and legal obstacles, and desalination is energy-intensive and costly, with potentially damaging environmental impacts.[84] Other possible water augmentation approaches, such as cloud seeding or bulk water imports, would also have their own political and legal obstacles, potentially high costs, and possible negative effects on the environment.[85]

Watershed management is a possible avenue for water augmentation in Arizona that would potentially garner greater consensus from the public and water policymakers in supporting investments and legal reforms. Watershed management is the improved maintenance of forests for the purpose of protecting and enhancing water supplies, including in particular the removal of scrub brush, immature trees, and invasive species from a catchment.[86] Watershed management has many potential benefits. First, removal of some vegetation, such as invasive species or scrub brush, can enhance forest health by allowing other trees to fully mature.[87] Second, vegetation removal could result

83. Rhett B. Larson, *Innovation and International Commons: The Case of Desalination under International Law*, 2012 UTAH L. REV. 759, 761 (2012).

84. *Id.* at 766.

85. Larson, *supra* note 10, at 759–65.

86. *See* Diane E. McConkey, *Federal Reserved Rights to Instream Flows in the National Forests*, 13 VA. ENVTL. L.J. 305, 310–11 (1994); *see also* Brandon Loomis, *Reduction in Tree Cover Over Rivers Could Mean More Water Flow*, USA TODAY: AZ. CENT. (Oct. 30, 2015), http://www.azcentral.com/story/news/arizona/investigations/2015/10/31/reduction-tree-cover-over-rivers-could-mean-more-water-flow/74882770/ [https://perma.cc/CX62-Z8CT].

87. *Id.*

in decreased wildfire risks.[88] Third, the improved forest health and decreased wildfire events would decrease erosion and runoff to rivers and thus improve water quality and wildlife habitat.[89] Fourth, responsible and sustainable thinning of forests could increase flows to the river by removing plants that would otherwise have taken up that water, and thus augment water supplies.[90]

Improved forest management protects snowpack from melting too fast, and limits water losses from evaporation.[91] Additionally, without effective watershed management, wildfires may expose forest snowpack to greater evaporation losses.[92] Decades of research throughout forests in the western U.S. have documented the potential for improved forest management to enhance water supplies.[93]

The recognized benefits and the broad support for watershed management in Arizona can be illustrated by the ongoing implementation of the Four Forest Restoration Initiative ("4FRI").[94] This endeavor is the largest watershed management project in the United States. It is aimed at improving water supplies in Arizona by rehabilitating the large ponderosa pine forests in the Verde River basin. The Verde River is one of the main tributaries of the Gila River and a region within the jurisdiction of the Gila River GSA.[95] The 4FRI project commenced in 2011 and includes four national forests.[96] The project is a partnership between the U.S. Forest Service, state and tribal land management agencies, local governments, non-governmental conservation organizations, and water and energy utilities.[97] It aims to rehabilitate 2.4 million acres of forest land in the upland regions of the Verde River basin, including forest thinning, invasive species removal, prescribed preventative forest burns, and incorporation of a 20-year adaptive management plan.[98] Many of the parties promoting and en-

88. *Id.* The ultimate effectiveness of watershed management in addressing wildfire concerns is the subject of intense scholarly debate. *See generally* WILDFIRE POLICY: LAW AND ECONOMICS PERSPECTIVES (Karen Bradshaw Schulz & Dean Lueck eds., 2012).

89. *Id.*

90. *Id.*; *see also* Loomis, *supra* note 86.

91. Alden R. Hibbert, *Water Yield Improvement Potential by Vegetation Management on Western Rangelands*, 19 J. AM. WATER RES. ASSOC. 375, 378–79 (1983).

92. *See generally id.* at 379.

93. Charles A. Troendle, Marc S. Wilcox, Greg S. Bevenger, & Laurie S. Porth, *The Coon Creek Water Yield Augmentation Project: Implementation of Timber Harvesting Technology to Increase Streamflow*, 143 FOREST ECOLOGY & MGMT 179 (2001).

94. Paul Summerfelt, *Will AZ Learn or Burn? Can AZ Learn to Burn?: The Flagstaff Experience*, 48 ARIZ. ST. L.J. 157, 176 (2016).

95. Annette Fredette, *4FRI and the NEPA Process*, 48 ARIZ. ST. L.J. 139 (2016).

96. Karen Bradshaw Schulz & Dean Lueck, *Contracting for Control of Landscape-Level Resources*, 100 IOWA L. REV. 2507, 2537–40 (2015).

97. Diane Vosick, *Democratizing Federal Forest Management Through Public Participation and Collaboration*, 48 ARIZ. ST. L.J. 93 (2016).

98. *Id.*

gaging in the 4FRI are also parties to the Gila River GSA, and their participation is motivated (in part) by the desire to enhance stream flows in the basin to alleviate water disputes.[99]

Despite the potential benefits from watershed management programs like the 4FRI, such vegetation removal projects can negatively impact wildlife habitat if done unsustainably, resulting in reduced shade cover, fewer nesting areas, and increased access by grazing livestock to fragile river banks.[100] Additionally, removing scrub brush, immature trees, and invasive species for improved forest health can be expensive, and lacks reliable returns on investments; partly because such removed vegetation has a narrow trunk diameter unsuitable for timber.[101] Burning removed vegetation for energy or using removed vegetation for paper production are also possibilities, but such industries can result in pollution from energy production emissions and paper manufacturing.[102]

Watershed management projects have potential legal challenges in addition to these environmental and economic risks. Under prior appropriation regimes, the law distinguishes between developed water and salvaged water in allocating water rights.[103] Developed water is new water imported into a catchment not previously part of the basin—like bulk water imports or sea water desalination.[104] Salvaged water, on the other hand, is water that is part of the basin but not accessible, and is then made usable by human intervention.[105] An example of salvaged water is brackish groundwater—found in deep, fossil aquifers, developed through advanced drilling techniques, and made usable by water treatment.[106]

Developed water is owned by the party that invested in its generation, and the rights to that generated quantity of water are independent of the prior appropriation system.[107] However, salvaged water remains part of the priority system, and the party that salvages the water by making it accessible and usable has no special or superior

99. *Id.*

100. H. Michael Rauscher, *Ecosystem Management Decision Support for Federal Forests in the United States: A Review*, 114 FOREST ECOLOGY & MGMT 173 (1999).

101. Elizabeth Long, Wyoming v. USDA*: A Look Down the Road at Management of Inventoried Roadless Areas for Climate Change Mitigation and Adaptation*, 40 ECOLOGY L.Q. 329, 341 (2013); *but see* Schulz & Lueck, *supra* note 96, at 2539 (discussing the incentives some forest landowners have to invest in watershed protection).

102. *Id.*; *see also* Emery Cowan, *How Good Earth's Plans Have Played Out*, ARIZ. DAILY SUN (Sept. 26, 2015), http://azdailysun.com/news/local/how-good-earth-s-plans-have-played-out/article_70741036-707d-508c-8ac9-a94e1ea8b999.html [https://perma.cc/Q8WA-FFTM].

103. Larson, *supra* note 10, at 765–67.

104. *Id.* at 766.

105. *Id.*

106. *Id.*

107. *Id.*

claim to the water.[108] For example, in *Southeastern Colorado Water Conservancy District v. Shelton Farms*, a party that removed invasive species from the banks of a stream claimed rights to the augmented water created by such removal.[109] The court held that such water was salvaged water and subject to prior appropriation.[110]

The distinction between developed and salvaged water is both highly relevant, and potentially highly problematic, for water augmentation projects in general, and for watershed management initiatives in particular. Water generated from seawater desalination is likely developed water, whereas water generated from desalinating brackish groundwater or saline-contaminated surface water is likely salvaged water.[111] This distinction thus potentially encourages seawater desalination over treating pollution or improving in-land water supplies.[112] Water generated through watershed management is likely salvaged water, as it mirrors in most respects the exact facts of the Shelton Farms case, which held that water generated by invasive species removal be salvaged and subject to a senior rights holder's priority and a call on the river. In such a case, what incentives exist for improved watershed management if those investing in such management cannot secure the benefit of augmented water? And how can the law in Arizona be reformed to encourage watershed management like the 4FRI as a means of advancing the resolution of the GSAs?

### B. *New Water and Refugee Host Communities*

Similar questions confront communities in Lebanon and Jordan that host ever-growing Syrian refugee populations, although the stakes are even higher. Can water disputes be avoided or mitigated between host communities and refugees by reforming laws to encourage development of new water supplies? In an attempt to respond to this question, the U.S. Agency for International Development ("USAID") granted $1.94 million to an international partnership between Arizona State University, Zero Mass Water, GreenCo, H2O for Humanity, MercyCorps in Jordan, and the René Moawad Foundation in Lebanon to address water security issues in the Middle East and North Africa. The project is called "A Holistic Water Solution for Underserved and Refugee Host Communities in Lebanon and Jordan" ("The Project").[113]

108. *Id.*

109. Se. Colo. Water Conservancy Dist. v. Sheldon Farms, Inc., 529 P.2d 1321, 1323–24 (Colo. 1974).

110. *Id.* at 1325.

111. Larson, *supra* note 10, at 765–67.

112. *Id.*

113. For more information about the project, see *A Holistic Water Solution for Underserved and Refugee Host Communities in Lebanon and Jordan*, ARIZ. STATE UNIVERSITY, https://sustainability.asu.edu/sustainabilitysolutions/programs/solutions

The Project is holistic in the sense that it attempts to address the four primary aims of water policy—quality, quantity, sustainability, and security. The Project addresses water quality by adapting the successful business model and technology used by H2O for Humanity ("HFH") in serving tens of thousands of people in India in the context of refugee-host communities in Lebanon and Jordan.[114] HFH implemented reverse osmosis water treatment kiosks in communities where entrepreneurs treat brackish groundwater sources and sell drinking water-quality water in businesses that are sustainable with charges as low as 0.2 cents per liter.[115]

On the quantity aspect of this holistic approach, Zero Mass Water ("ZMW") has developed a solar-powered unit that can generate drinking water from water vapor in the air.[116] This technology allows for augmented water supplies at the household level relying on renewable, low-cost energy. On the sustainability aspect of water policy, Arizona State University has connected HFH's technology to solar power that allows the water treatment system to operate independent of the grid and the modulate between on-and-off-grid power, thus making the system both more reliable and resilient in power outages and more sustainable in relying on a renewable energy source.[117] The concept of sustainability is not just environmental sustainability, but also the financial sustainability of the project. Each kiosk is either integrated within the existing water utility network of the host community or else is implemented as an independent business, providing training and employment opportunities while establishing a sustainable business model with water charges below market rates.[118] The water security aspect of the project is achieved with GreenCo's Flat Pak technology, which is a food-grade plastic collapsible water storage tank that allows each kiosk to store water in cases of system failure, drought, or other emergencies.[119]

Cutting-edge sustainable treatment, augmentation, and storage technologies can take the project only so far. In-country partners—MercyCorps in Jordan and the René Moawad Foundation in Lebanon—provide community-level guidance to ensure access, training, site-selection, and remote monitoring of system integrity and water

services/holistic-water-solutions/ [https://perma.cc/JBH4-MM5H] (last visited Sept. 25, 2017) [hereinafter *A Holistic Water Solution*].

114. For more information about H2O for Humanity, see H2O FOR HUMANITY, http://www.h2oforhumanity.com/ [https://perma.cc/EMM8-RLLK] (last visited Sept. 17, 2017).

115. *Id.*

116. For more information about Zero Mass Water, see ZERO MASS WATER, https://zeromasswater.com/technology/homeowner/ [https://perma.cc/L556-88XM] (last visited Sept. 25, 2017).

117. *See A Holistic Water Solution*, *supra* note 113.

118. *Id.*

119. For more information on GreenCo, see GREENCO WATER, http://greencowater.com/ [https://perma.cc/95YU-LDXZ] (last visited Sept. 25, 2017).

quality.[120] The partnership established in this project, and the support of USAID, aims to avoid or mitigate water disputes between refugee-host communities and Syrian refugees by providing affordable and sustainable augmented water supplies in the communities, as well as employment opportunities, community engagement in water resource development, and applied research in water treatment, water supply augmentation and storage, and water governance.

The governance aspect of the project raises important research questions that go the heart of the long-term viability of such water supply enhancement projects. Who does, or should, own the generated water supplies? How do ownership concepts change between countries, and even between and within a community? How can the project be adapted to respond to different community conceptions of water rights and water valuation? What legal and administrative hurdles exist that might frustrate efforts to improve water access in refugee-host communities, and how might law be reformed to encourage investment in community- and household-scale sustainable water solutions to respond to the strains placed on water supplies by the refugee crisis?

## III. LEGAL REFORMS FOR NEW WATER TO ADDRESS WATER DISPUTES

As noted above, both the Syrian refugee crisis in Jordan and Lebanon, and the ongoing water disputes in Arizona under the GSA, raise difficult legal questions surrounding water rights and the possibility of legal reforms to encourage a "grow the pie" approach to water dispute resolution. This Section discusses and evaluates possible legal reforms to encourage water augmentation to accelerate the resolution of the GSAs and to alleviate strains on water resources in refugee-host communities in Lebanon and Jordan.

### A. *Reforms for New Water in the Arizona's GSAs*

For legal reforms aimed at water supply augmentation to meaningfully advance the GSAs, such reforms should simultaneously address the complicated issue of subflow. Many subflow pumpers risk losing their water rights entirely in the adjudication if their pumping is deemed surface water and with a priority date so junior as to be perpetually subject to call on oversubscribed rivers. But such pumpers—some of whom are cities and towns—must find some way to maintain their water supplies while at the same time making senior water-rights holders whole for interference with vested rights. Addressing the sub-

120. For more information on the René Moawad Foundation, see RMF, http://www.rmf.org.lb/ (last visited Sept. 17, 2017). For more information on Mercy Corps in Jordan, see MERCY CORPS: JORDAN, https://www.mercycorps.org/countries/jordan [https://perma.cc/5UWU-4XCD] (last visited Sept. 25, 2017).

flow problem should be coupled with the need for greater investment in water augmentation projects, like watershed management similar to the 4FRI. One possible innovation to simultaneously address subflow and encourage investment in watershed management is the establishment of regional water augmentation authorities ("RWAAs").

Under this RWAA approach, the Arizona Department of Water Resources ("ADWR") would apply a mathematical model to assess a well's relationship to subflow, based on factors including its depth, proximity to the stream, pumping capacity, and the well's surrounding hydrogeology. The model would generate a conservative estimate of the well's impact on senior surface water-rights holders. That estimate would then be used by ADWR to establish an augmentation fee owed by the subflow pumper, and to be paid to the RWAA. The RWAA would be a quasi-municipal entity, authorized by statute and similar to already-existing water conservation or irrigation districts, to collect augmentation fees paid by RWAA members and based on the ADWR model. The RWAA boundaries would be based on the geographies of river sub-basins. Members would voluntarily join the RWAA. Subflow pumpers within the RWAA boundaries who choose not to become RWAA members would then pursue final adjudication of their water rights under the GSA, and risk the possibility that the GSA court would find that their well is appropriating subflow and has a priority date subject to a call on the river.

The RWAA would then use the funds paid by its members' fees to invest in water augmentation projects to compensate senior water-rights holders for the impacts on their vested water rights from RWAA members' subflow pumping. As long as RWAA members pay their fee, they are shielded from liability to senior rights holders for any interference with those vested rights caused by member subflow pumping. The RWAA would assume responsibility for mitigating impacts through investing in water augmentation projects and would assume liability for any failure to adequately offset impacts to senior rights holders. One advantage of the RWAA is that it lowers the enormous transaction costs associated with negotiating with thousands of potential subflow appropriators by having those pumpers become members of an association that negotiates, settles, and compensates on their behalf.

The RWAA could pursue augmentation in several ways. Brackish groundwater desalination, in a form similar to that used in the projects in Jordan and Lebanon, could provide a source of augmented water.[121] Desalination has potentially high energy and environmental costs, but the technology has rapidly improved in both energy efficiency and overall costs in recent years, and the solar-energy compo-

121. *See generally* Symposium, *Desalination in California: Should Ocean Waters Be Utilized to Produce Freshwater?*, 57 HASTINGS L.J. 1343, 1343–46 (2006).

nents integrated in the USAID holistic water solutions project could further reduce costs and enhance sustainability.[122] The viability of such an approach would depend on whether these desalination systems could be scaled up to meet the demands of senior water-rights holders, and the extent to which such systems could address environmental impacts of desalination, including the disposal of the brine waste stream from reverse osmosis treatment.

In addition to brackish groundwater desalination, RWAAs could pursue watershed management projects to mitigate member impacts on senior water-rights holders, by investing in projects similar to the 4FRI. But to make such investments viable, reforms may be necessary to the way the law treats supplies augmented by watershed management or treatment of brackish sources, as both are likely to be considered salvaged water.

To encourage investments in forestry management and treatment of brackish water sources, water law could be reformed to grant some limited rights to salvaged water. For example, all water rights transactions within a particular area could include a hold-back of a certain percentage of the total quantity of water transferred. The water held back from each transfer would be held in trust by ADWR for the preservation of in-stream flows, and as a discounted source of water available to certain designated groups, such as RWAAs.[123]

First, discounted water rights could be purchased by RWAAs that invest in watershed management. Second, RWAAs engage in remediation of water contamination or brackish sources. The discount on those water rights would depend on the RWAA making a demonstration that investments improved water access. Such discounted water rights could then be transferred by the RWAA to senior water-rights holders, who would then hold those rights with the same priority date as the rights impacted by RWAA member pumping.

The establishment of RWAAs would make it simpler for senior water right holders to identify parties to compensate them for subflow impacts, while still allowing subflow pumpers to retain some access to water supplies. Furthermore, the fees paid to RWAAs could provide some funds to invest in water augmentation projects, like improved forestry management, that sometimes struggle to attract capital. By establishing a bank of discounted water rights available to RWAAs, salvaged water efforts like forestry management can result in actual claims to get water without a wholesale recognition of priority for salvaged water projects, which could prove a reform far too disruptive for most prior appropriation regimes. RWAAs could thus be a critical

122. Rhett B. Larson, *Innovation and International Commons: The Case of Desalination under International Law*, 2012 UTAH L. REV. 759, 766 (2012).

123. *See, e.g.*, Ivan M. Stoner, *Leading a Judge to Water: In Search of a More Fully Formed Washington Public Trust Doctrine*, 85 WASH. L. REV. 391 (2010).

innovation in moving toward a resolution of Arizona's GSAs through investment in new water sources.

### B. *Reforms for New Water in Refugee Host Communities*

New water development like the holistic water solutions project in Lebanon and Jordan will likely require reforms similar in degree, if not in kind, to the establishment of RWAAs to address Arizona's water dispute challenges. While a deep examination of the laws impacting water development in Jordan and Lebanon is outside the scope of this Article, based on my experience in these countries, there are some possible reforms that would encourage investment in new water sources aimed at mitigating water disputes in refugee host communities.

First, government exemptions for well permits and fees for any well with a total dissolved solids ("TDS") concentration above 1,800 ppm would lower the costs associated with treating those wells with salinity levels too high to provide drinking water without additional treatment. Second, legal reforms should clarify that parties generating augmented water from water vapor—like the ZMW system—hold title to that generated water, which would encourage investments and expansions of such systems. Third, laws that recognize title in the brine waste stream from brackish groundwater treatment in the treating party would also encourage implementation of brackish groundwater reverse osmosis systems like H2O for Humanity. In those instances, even if the government retains title to the groundwater, the brine stream can be sold for construction purposes and provide an additional source of revenue for parties investing in water treatment, to make those businesses financially sustainable.

While not necessarily a legal reform, more research is needed in Jordan, Lebanon, and throughout the Middle East and North Africa ("MENA") region to map out differences in communal conceptions of water rights and water valuation. The concept that water is an inalienable right to all is a principle embedded in Sharia law. While Sharia is not formally codified in all—or even most—MENA countries, it remains influential in many ways. The Majalla, or Ottoman Code, on water resource management has influenced water laws in many parts of the MENA region and creates a certain degree of uniformity within the region, some of which is based on Sharia concepts that persist through the Majalla and into current domestic water laws and policies of former Ottoman states.[124] Even where such Sharia influences are absent or not pronounced, community norms may nevertheless recognize Sharia water law concepts, which could be accounted for in the implementation of new water projects in the MENA region.

124. *See* Ali Ahmad, *Islamic Water Law as a Comparative Model for Maintaining Water Quality*, 5 J. OF ISLAMIC L. & CULTURE 159 (2000).

Unsurprisingly, given its roots in the arid Arabian Peninsula, Sharia focuses a great deal on water rights and the resolution of water-related disputes.[125] Under Sharia, there are two fundamental water rights precepts.[126] First, *shafa*, or the "right of thirst," establishes a universal right for all humans to have access to drinking water.[127] Second, *shirb*, or the "right to irrigate," provides a right for farmers to water their crops.[128] While these two principles are interpreted and implemented in dramatically different ways depending on geography and sect, there are certain generalized principles, including a focus on equity in water distribution.[129] These interpretations can range from an absolute prohibition against charging for water services, to distinctions between private and public water rights with water charges being acceptable for private waters, to the degree to which certain taxes should apply to the development of water resources.[130] Increased research into whether and how the formal laws of MENA countries, and the norms of communities in the region, interpret and implement these rights would assist in adapting new water projects to the unique legal environment and community norms in which projects are implemented.

## CONCLUSION

* * *

While Arizona's water dispute challenges complicate long-term water planning and generate uncertainties in water markets, the water challenges facing refugee host communities in Lebanon and Jordan are orders of magnitude more serious and complicated. Water is frequently a source of contention, as illustrated by the very word "rival," which comes from the Latin word *rivalis*—meaning people who share a river.[131] And yet despite the potential for water disputes, water is more frequently a source of human cooperation. It is not coincidence that our oldest civilizations—and thus our earliest successes in broad, complex cooperative systems—arose around rivers in the desert, like

125. Naser I. Faruqui, *Water, Human Rights, and Economic Instruments: The Islamic Perspective*, 9 WATER NEPAL 197, 203 (2003). Indeed, the word "*Shari'ah*" itself is closely related to water, and can be interpreted to mean "the source of water." James Salzman, *Thirst: A Short History of Drinking Water*, 18 YALE J.L. & HUMAN. 94, 100 (2006).

126. Faruqui, *supra* note 125, at 201–03.

127. *Id.*; *see also* Chibli Mallat, *The Quest for Water Use Principles*, *in* WATER IN THE MIDDLE EAST (M.A. Mallat & I.B. Chibli eds., 1995).

128. Faruqui, *supra* note 125, at 202.

129. *Id.*; *see also* Mallat, *supra* note 127.

130. Jackson Morill & Jose Simas, *Comparative Analysis of Water Laws in MNA Countries*, *in* WATER IN THE ARAB WORLD (N. Vijay Jagannathan, Ahmed Shawky Mohamed, & Alexander Kremer eds., 2009).

131. Joseph W. Dellapenna, *International Law's Lessons for the Law of the Lakes*, 40 U. MICH. J.L. REFORM 747, 763–64 (2007).

the Tigris, Euphrates, and Nile. Water can be a source of cooperation with adequate investment and wise management. And sometimes, new water sources can serve as a catalyst for transforming water disputes into opportunities for water cooperation.