THE PRIVATE SECTOR'S ROLE IN ARIZONA'S WATER FUTURE

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Professor Buzz Thompson's book Liquid Asset *explores the critical partnership between the public and private sectors in water management. Water management has taken center stage in Arizona, where Colorado River shortages, groundwater depletion, and persistent water rights litigation has placed national media attention on the state. The principles set out in Professor Thompson's book can guide Arizona's engagement with the private sector to address its water challenges. This essay identifies four areas for private sector engagement in Arizona – innovation in cooling technology, water rights markets, water infrastructure financing, and water data access. This essay then suggests how partnering between the state of Arizona and businesses can advance water security in these four areas.*

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INTRODUCTION

The water sector is not an obviously hospitable field for private business. Water is often treated as a public trust resource, owned by the state and held in trust for the benefit of its citizens. Thus, businesses may be reluctant to fully engage in a field where the asset may never be fully "owned" independent of the government. Water provisioning is typically a natural monopoly, with high initial fixed costs and low marginal costs. This limits competition and allows the state to play a role in setting prices. Water is also often considered a human right, essential for all life, for a flourishing environment, and with deep cultural and political meaning. Water's nature as both an essential resource and cultural symbol makes its potential commodification problematic. Nevertheless, because water is embedded in all products and necessary for all services, some degree of commodification is inevitable so long as there are commodities. As such, private business may struggle to find its place within the water sector, but the water sector should make a place for such enterprises. Making room for private enterprises in water management is critical, as a confluence of climate change, increased demand, and contamination have resulted in serious water crises in many parts of the world, requiring an "all hands on deck" approach.

Professor Buzz Thompson, in his book *Liquid Asset: How Business and Government Can Partner to Solve the Freshwater Crisis*, wrote: "Private organizations can contribute to a sustainable and resilient water future, yet private participation in the water sector raises questions about the appropriate role of government versus the private sector in resolving water issues."[1] This Essay builds on Professor Thompson's book by applying its principles and suggestions to water challenges facing the state of Arizona. Arizona, like many arid regions and its neighboring states in the Southwest, confronts increasing water variability, groundwater overdraft, growing populations, and heated legal battles over water rights. These challenges can make Arizona a laboratory for private sector engagement in water management.

In *Liquid Asset*, Professor Thompson concludes with four broad areas of suggested reforms related to technology, markets, financing, and data. This Essay proceeds in four parts, based on

1. BARTON H. THOMPSON, JR., LIQUID ASSET: HOW BUSINESS AND GOVERNMENT CAN PARTNER TO SOLVE THE FRESHWATER CRISIS 1 (2024).

those areas of reform. In Part I, I discuss the role of the private sector in technological innovation, using the example of advances in low- or no-water coolant technologies in Arizona. In Part II, I discuss the role of the private sector in water markets, noting the potential role of new industries seeking to buy more drought resilient crops in Arizona. In Part III, I discuss potential private financing for water infrastructure and water augmentation, including as part of the settlements of tribal water rights disputes in Arizona. In Part IV, I discuss the role of the private sector in improving water data access and accuracy, including new pressures on landowners to partner with companies to install smart meters on wells in rural Arizona. These examples and related reforms illustrate the promise of partnerships between the public and private sector in the growing arid regions of the American Southwest.

I. PRIVATE SECTOR & INNOVATION IN WATER TECHNOLOGY

In Chapter 7 of his book, Professor Thompson relies on the example of the government of Singapore's close partnership with private technology companies in advancing water management. "This collaboration has led to a formidable water technology sector that has both allowed Singapore to meet its water needs and created a business growth area for the island nation."[2] Similar partnership opportunities exist in Arizona to address a growing challenge to both Arizona's water management and economic development.

In recent years, data centers have expanded rapidly in and around Phoenix, Arizona. Data centers contain servers, network equipment, storage systems, and related infrastructure to house and distribute large amounts of digital computer data. Central Arizona has become a popular region for data centers for several reasons. Arizona has historically had a reliable power grid and relatively inexpensive and plentiful real estate. Arizona's tax structure and electricity and water rates have also made it a desirable location for data centers. Arizona also has a climate well-suited for data centers, with limited floods and freezes, and warm, dry air that lends itself well to evaporative cooling of data centers.[3]

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2. *Id.* at 238.

3. For an overview of the growth of data centers in Arizona and its cause, *see* Pranshu Verma, *In the Shadows of Arizona's Data Center Boom, Thousands Live Without Power*, WASH. POST, Dec. 23, 2024.

Data centers consume an enormous amount of energy, with data centers accounting for 94% of the growth in demand for energy in central Arizona.[4] That energy consumption requires an enormous amount of water, both in water consumed in power generation, or water used in the evaporative cooling of the data center equipment itself.[5] The water and energy demands for these data centers have resulted in cities in central Arizona facing political backlash for favorable tax policies aimed at attracting such businesses, as their energy and water demands have resulted in rising utility rates in their host communities.[6] Some larger water and energy users, like semiconductor manufacturers, have a growing presence in Arizona but have been less controversial, as communities have valued the tradeoff in jobs created per acre-foot of water consumed. Data centers, on the other hand, have been perceived as consuming water without generating sufficient employment opportunities in the community.[7]

A low- or no-water coolant technology for data centers could facilitate the growth of the industry in the state and mitigate community opposition based on sustainability concerns. Furthermore, if such technology could be transferred to quantum computing coolant, it would allow Arizona and the megaregion of the Southwest to maintain its trajectory as a growing technology hub. If such technology is scalable, it could be used to cool larger facilities, like the Palo Verde Nuclear Power Plant in Arizona. The Palo Verde Plant is the only nuclear power plant in the world not built on a major body of water and depends entirely on effluent generated by surrounding cities for coolant water.[8] If the power plant could be cooled by other, less water-intensive means, cities

4. Joe Dana, *Data Centers, Not Homeowners, Fueling Arizona's Steep Energy Demand*, 12NEWS, Dec. 20, 2024, https://www.12news.com/article/money/consumer/arizona-data-center-demand-growing-100x-more-other-power-customers/75-c3304c6a-1191-4dc0-87a7-2e2d85676bac.

5. Jamie Hailstone, *What Can Be Done About Power-Hungry and Thirsty Data Centers?*, FORBES, Sept. 13, 2024.

6. Russ Wiles, *New Meta Data Center in Mesa Makes Sustainability Pledges Amid Critics' Doubts*, ARIZ. REPUBLIC, (Jan. 31, 2025.

7. Helen Li, *TSMC and Intel Innovate to Reduce Water Footprint in Chip Productions*, BUS. INSIDER, July 31, 2024, https://www.businessinsider.com/chip-production-water-usage-tsmc-intel-2024-7; *see also* Kyle Backer, *Does Data Center Power Need Pose Risk to Continued Growth*," AZBIGMEDIA, May 22, 2024, https://azbigmedia.com/real-estate/does-data-center-power-need-pose-risk-to-continued-growth/.

8. Ryan Randazzo, *Huge Nuclear Plant in Arizona Desert Seeking New Sources of Water – It Uses 23 Billion Gallons Per Year*, ARIZ. REPUBLIC, May 1, 2022.

could recycle their wastewater to other uses, including groundwater recharge and direct potable reuse.

Forced Physics DCT, an Arizona-based company, has developed JouleForce, a small metal component comprised of micro-vents to introduce air around the heating technology, creating a molecular beam that drops temperature without the use of water.[9] The micro-vent components can be stacked onto larger and larger facilities, making them potentially scalable to something like a power plant. Forced Physics has deployed this system on data centers owned by Sun West Engineering in Phoenix, which has been successfully cooled by the JouleForce technology while stored without air conditioning with outdoor temperatures exceeding 110 degrees.[10]

Such innovations could be promising for Arizona's growth in the technology sector, and potentially for water sustainability in power generation. But this technology presents risks as well. If data centers no longer require evaporative cooling because of advances in low- or no-water cooling methods, then perhaps Arizona and its warm dry air will be a less attractive destination for technology companies. The very technology allowing these companies to sustainably operate in Arizona could also allow them to move to greener, and wetter, pastures. This risk of losing these industries may grow as real estate prices in central Arizona continue to climb. Nevertheless, Arizona's low-risk geography and tax incentives could continue to attract technology companies. With companies like Forced Physics, the potential to liberate wastewater used as power plant coolant for other uses in the drought-stricken region could open new avenues for the semiconductor industry in Arizona.

Heat mitigation, at both the micro- and macro-levels, will be a principal challenge for large desert cities, like Phoenix. Such cities reside on the vanguard of climate change while still seeking to grow and diversify their economies that have been reliant on irrigated

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9. Rich Miller, *Forced Physics Unveils Data Center Cooling System*, DATA CENTER FRONTIER, March 26, 2019, https://www.datacenterfrontier.com/cooling/article/11429688/forced-physics-unveils-data-center-cooling-system.

10. Terri Fritts, Forced Physics Data Center Technology Celebrates First Installation of Edgeility System Designed for Edge and On Premise Locations, BUS. WIRE, April 18, 2021, https://www.businesswire.com/news/home/20210818005242/en/Forced-Physics-Data-Center-Technology-Celebrates-First-Installation-of-Edgeility-System-Designed-for-Edge-and-On-Premise-Locations.

agriculture for decades. Partnering with the private sector, including companies like Forced Physics, to develop heat mitigation technologies will be critical in overcoming this challenge. As Professor Thompson notes: "Ultimately, government and the private sector can best address the freshwater crisis by working together .... The public sector ... must recognize the immense ingenuity and value that the private sector can bring and integrate into the overall fabric of water management."[11]

The law can play a role in facilitating such a public-private partnership advancing low- or no-water cooling technologies. One possible approach would be to use condition zoning and building permit approvals for data centers upon achieving certain water efficiency levels. Data centers that were dependent upon groundwater sources for cooling technologies that then shift to less water-intensive measures could be approved as "groundwater savings facilities" and granted credits for conserved groundwater. These credits could be sold and pledged as part of subdivision developers seeking platting approval consistent with established groundwater management requirements. Power plants that move toward innovative cooling approaches could avail themselves of similar programs. Palo Verde could secure groundwater credits for foregoing wastewater as coolant and instead recharge aquifers, or else receive credits for offsetting groundwater that might otherwise be pumped to meet drinking water demands if wastewater is cleaned and distributed for direct potable reuse. These measures could create incentives for effective partnerships between communities seeking to welcome the technology sector, but wary of returns on their water and energy investment.

II. THE PRIVATE SECTOR & WATER MARKETS

The rising technology sector in Arizona presents many opportunities and challenges, like heat mitigation, which Arizona has not had to face historically. Arizona's economy has traditionally been defined by the "5 Cs" – copper, cotton, citrus, cattle, and climate. Copper mining, tourism, cattle ranching, and irrigated agriculture are all either water-intensive (in the case of ranching, mining, and farming) or else water-dependent (in the case of tourism for Arizona's scenic rivers, canyons, and ski slopes). Growth in new areas, like technology, will require careful tradeoffs

11. THOMPSON, *supra* note 1, at 238-39.

with these existing pillars of Arizona's economy.

Irrigated agriculture makes up more than 70% of water use in Arizona. Any plans to diversify Arizona's economy, grow its population, and adapt to climate change will require some measure of change in either irrigation technology or the types of crops grown in Arizona. Arizona grows cotton and citrus but has also become a major producer of green vegetables, particularly in southwestern Arizona in Yuma, along the banks of the Colorado River.[12] Yuma is known as the "Winter Salad Bowl of America," with the region accounting for most vegetables consumed by Americans in winter months.[13]

Alfalfa, one of the dominant crops in Arizona and a particularly water intensive source of cattle and dairy feed, has become controversial.[14] A company owned by the Saudi sovereign wealth fund operates alfalfa farms in Arizona to feed Saudi dairy cows.[15] This operation has brought intense scrutiny to alfalfa growing in general in Arizona and across the Colorado River Basin. Alfalfa alone consumes around 1.5 million acre-feet of water per year across the Colorado River Basin.[16] However, Arizona's alfalfa production supports historic cattle ranching and dairy industries in the region.[17] Arizona's climate allows production of alfalfa year-round[18] Additionally, Arizona's water sources are generally highly saline, meaning Arizona often needs a crop that is both salt-resilient and irrigated in a way that allows salt to leach out of the

12. Valorie H. Rice, *Arizona Agriculture: A Case Study in Contrasts* (U. Ariz. Econ. & Bus. Res. Center, August 26, 2024) *available at* https://www.azeconomy.org/2024/08/economy/arizona-agriculture-a-study-in-contrasts/.

13. Dari Duval, "Arizona's Season Role in National Supply of Vegetables & Melon Specialty Crops," THE UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION (September 2023) available at https://extension.arizona.edu/sites/default/files/2024-08/az2064-2023.pdf.

14. *See, e.g.*, Suman Naishadham, *In Drought-Stricken Arizona, Fresh Scrutiny of Saudi Arabia-Owned Farms' Water Use*, PBS, April 28, 2023, https://www.pbs.org/newshour/politics/in-drought-stricken-arizona-fresh-scrutiny-of-saudi-arabia-owned-farms-water-use.

15. Hiroko Tabuchi, *Water-Stressed, Arizona Says State Will End Leases to Saudi-Owned Farm*, N. Y. TIMES, Oct. 3, 2023.

16. Jonathan Thompson, *The Colorado River's Alfalfa Problem*, HIGH COUNTRY NEWS, Sept. 1, 2022.

17. Gina Dockstader & Paul Orme, *Alfalfa is Not Arizona's Water Use Enemy: Why We Grow So Much of It Here*, ARIZ. REPUBLIC, April 24, 2024.

18. Isabel Webb Carey, *Why Arizona Keeps Growing Alfalfa in the Desert Even as Water Concerns Grow*, BLOOMBERG NEWS, July 24, 2023.

soil to preserve soil health.[19] Alfalfa is one of the crops that helps address Arizona's salty water challenges. Alfalfa is a relatively salt-resilient crop, and the method for irrigating alfalfa can facilitate leaching salts out of the soil to preserve soil health and prevent buildup of salinity.[20]

Given the demand for crops like alfalfa, how well Arizona is suited to produce these crops, and the unique salinity challenges in Arizona, shifting to different, more drought- resilient crops is complicated and may require greater engagement from the private sector. For example, for decades many farmers in Arizona's Verde River basin grew crops, like corn or alfalfa, during low-flow seasons of the river. [21] Diverting water during low-flow seasons reduces groundwater recharge, lowers hydraulic head preventing the river from reaching other water users and supporting riparian habitat, and increases energy costs associated with pumping reduced supplies. Simply shifting to crops with a growing season during higher flows – like barley – would create significant water and energy savings. Farmers were reluctant to shift from those crops to barley, as the only market for barley in Arizona was for animal feed, and thus barley was sold at a discount.[22] The only way for farmers to recoup investments made in shifting to barley production would be to sell barley at a premium price, such as to malt houses to produce beer. The main obstacle, however, was the lack of malt houses in Arizona. The Nature Conservancy (TNC) saw an opportunity to attract malt house operations to Arizona to create a market that would make crop shifts for water savings more economically viable.[23]

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19. Don Miller, *Drought Brings Added Salinity Issues for Alfalfa*, HAY & FORAGE GROWER MAG., Dec. 31, 2021, https://hayandforage.com/article-3750-begin-by-cutting-your-nitrogen-bill-here.html.

20. Dockstader & Orme, *supra* note 17; *see also* Don Miller, *Drought Brings Added Salinity Issues for Alfalfa*," HAY & FORAGE GROWER MAG., Dec. 31, 2021, https://hayandforage.com/article-3760-drought-brings-added-salinity-issues-for-alfalfa.html.

21. Sheldon Alberts, *Growing Crops, Feeding People, and Conserving Water* (Walton Fam. Found., March 8, 2018).

22. Jenny Rogers, *Barley Dreams: An Arizona Town Gambles on Beer to Save Water*," TNC MAG., Feb. 29, 2020, https://www.nature.org/en-us/magazine/magazine-articles/barley-dreams/#:~:text=An%20Arizona%20town%20gambles%20on%20beer%20to%20save%20water.&text=Kim%20Schonek%20stands%20at%20the,winds%20of%20the%20Verde%20Valley.

23. Corey Hawk, *Arizona's First Malt House Saves Water and Supports Local Breweries*, CRONKITE NEWS, Sept. 19, 2018, https://cronkitenews.azpbs.org/2018/09/19/arizona-

TNC invested in the Sinagua Malt House in 2019 to create a local market demand for farmers in the Verde River Basin to sell barley at a premium price.[24] The Sinagua Malt House has since been acquired by a for-profit company that provides services to many local breweries in Arizona and purchases its barley from farmers in the Verde River Basin, saving over 200 million gallons of water in the months of June each year.[25] A similar opportunity may exist for some farmers in Arizona to shift to growing agave. Agave is a native desert plant that is highly drought resilient and is used to make tequila. Farmers could shift to growing agave in Arizona, but not without attracting more distilleries to produce tequila from locally grown agave. A growing tequila production industry in the region allows farmers to potentially make a shift to agave with a ready-made and expanding demand.[26]

These sorts of partnerships between local farmers, private foundations and non-profits like TNC, and private for-profit enterprises like Sinagua Malt show how the private sector can make needed impacts in the water sector. As Professor Thompson notes: "Solving the world's freshwater crisis will require expert analysis and design. The challenges are complex and will not be solved without the input of hydrologists, economists, and other experts, effective solutions also will require change agents who can overcome political inertia and foster support for needed new approaches. Three groups within the private sector – consultant, private foundations, and non-profits – are meeting these needs."[27] It has been through the cooperative efforts of these groups that Arizona has achieved meaningful water savings in the agricultural sector with shifts to barley production, and with potentially greater conservation in the future with shifts to agave.

A similar opportunity may exist in one of the areas of Arizona most impacted by drought. Shortage declarations in the Colorado

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malt-house-saves-water/#:~:text=Sinagua%20Malt%20%E2%80%93%20a%20malt%20house,and%20Arizona%20Wilderness%20Brewing%20Co. ; *see also* TNC, *Water Security for Arizonans*, https://www.nature.org/en-us/about-us/where-we-work/united-states/arizona/stories-in-arizona/water/.

24. Ruvani de Silva, *How Two Committed Conservationists Revitalized a River with Beer*, MODERN FARMER, March 14, 2024.

25. *Id.*

26. John Burnett, *As Americans Drink More Tequila, The Agave Industry in the Southwest Grows*, NPR, Sept. 3, 2023, https://www.npr.org/2023/09/03/1197461166/as-americans-drink-more-tequila-the-agave-industry-in-the-countrys-southwest-gro.

27. THOMPSON, *supra* note 1, at 185.

River have resulted in reduced deliveries through the Central Arizona Project, the canal that delivers a portion of Arizona's Colorado River allocation into central Arizona. In recent years, this shortage has eliminated nearly all agricultural deliveries of Colorado River water in Arizona, with significant impacts on farmers in Pinal County.[28] Bridgestone is partnering with Pinal County farmers to explore the possibility of a crop shift to guayule, a highly drought-resilient rubber plant. Arizona has no rubber production or manufacturing base, so no current market exists locally for farmers producing guayule.[29] However, if Bridgestone's efforts to pilot a program prove successful, farmers in Pinal County can preserve their agricultural way of life by producing a water efficient crop that attracts new industries and jobs to Arizona.

Legislation that provides tax benefits and land use laws favorable to rubber manufacturers, distilleries and malt houses could attract these industries and build a stronger local market for farmers to shift to more drought resilient crops. Arizona will also have to advance reforms in water law. For example, like many prior appropriation states, Arizona recognizes the doctrine of forfeiture, under which any water right holder may lose all or a portion of their water right due to non-use for five years – a "use it or lose it" regime.[30] Forfeiture can create perverse incentives, including for farmers to waste water with inefficient irrigation techniques or water-intensive crops rather than reduce water consumption and risk losing water rights.[31] Farmers may avoid shifting to more water efficient crops, regardless of market demands, to preserve their water rights. Arizona has made a potentially significant reform in recent years, however. Since 2021, water right holders can file a conservation plan with the state that, if approved, would shield conserved water from forfeiture.[32] These sorts of reforms allow for

28. Ximena Bustillo, *Arizona's Farms are Running Out of Water, Forcing Farmers to Confront Climate Change*, NPR, May 18, 2023, https://www.npr.org/2023/05/18/1176657700/arizona-farms-running-out-water-farmers-climate-change-colorado-river#:~:text=Personalize%20Your%20Experience-,Arizona%20farmers%20rely%20on%20drought%2Dstricken%20Colorado%20River%20to%20water,agree%20something%20needs%20to%20change.

29. Zayna Syed, *To Save Water, Arizona Farmers are Growing Guayule for Sustainable Tires*, POPULAR SCI, Nov. 13, 2022.

30. ARIZ. REV. STAT. § 45-141(C) (2025).

31. Rhett Larson and Brian Payne, *Unclouding Arizona's Water Future*, 49 ARIZ. ST. L.J. 465, 472 (2017).

32. Jorge Torres, *After 'Use It or Lose It' Water Policy, HB 2056 Allows Farmers to Keep Water, Still Use it Wisely*, ABC15, June 4, 2021, https://www.abc15.com/weather/impact-

greater adaptive capacity in water law, which will facilitate more engagement from the private sector in encouraging water conservation measures in the agricultural sector.

III. THE PRIVATE SECTOR & WATER FINANCING

Arizona's agricultural water consumption is not simply a matter of the kinds of crops it grows, but also how it grows those crops. A shift to more efficient irrigation methods could reduce water consumption without the need to shift to new crops and attract new markets. New irrigation methods and technologies can reduce water consumption while preserving productivity of traditional crops in many instances. These changes can be as simple as lowering sprinkler emitters to more complicated and expensive measures such as center pivot irrigation, laser leveling fields, or drip irrigation. The costs associated with making these shifts are high, even excluding the risks associated with potential forfeiture, which Arizona has hopefully mitigated with the new conservation plan option.[33] Each of these irrigation methods require significant capital investments for farmers already stretched with high insurance costs, water variability due to climate change, and uncertainty around labor and markets given instability in recent federal approaches to immigration and tariffs.[34]

Professor Thompson writes extensively about the challenges facing financing of water infrastructure in a broad sense, including municipal water providers. Farmers face similar challenges in irrigation infrastructure. As Professor Thompson wrote, "While private firms have helped increase the amount and diversity of financing available to water suppliers, the gap in available

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earth/after-use-it-or-lose-it-water-policy-hb-2056-allows-farmers-to-keep-water-still-use-it-wisely#:~:text=That%20changed%20this%20year%20thanks,losing%20it%20to%20the%20state.; *see also* ARIZ. REV. STAT. §§ 45-188 to -189 (2025).

33. Moriah Costa, *From Laser-leveled Fields to Drip Irrigation, Farms Stretch Water They Have*, TUCSON SENTINEL, April 12, 2014.

34. For impact on farming from tariffs, *see* Danielle Kurtzleben, "*China Put Steep Tariffs on U.S. Exports, Farmers are Worried*, NPR, April 12, 2025, https://www.npr.org/2025/04/12/g-s1-59682/trump-tariffs-farmers-china. For impact of immigration crackdown on farmers, *see* Billal Bahman, *Trump's Mass Deportations Are Pushing US Farms to Breaking Point*, NEWSWEEK, April 28, 2025. For rising insurance costs and water variability, *see* Leah Douglas, *U.S. Crop Insurance Payouts Rise Sharply as Climate Change Worsens Droughts, Floods*, REUTERS, Jan. 27, 2022, https://news.trust.org/item/20220127045744-w0mz1/.

financing for water infrastructure remains."[35] Larger municipal water providers have some bonding capacity and the ability to spread costs over a large customer base to help bridge some of that financing gap. Some larger irrigation districts, such as those in Yuma County, may approximate the ability of large municipal water providers to bridge the financing gap by issuing bonds.[36] For many farmers, however, they face financing challenges like smaller water providers, with fewer options to bridge the gap and greater risk than larger irrigation districts or municipal water providers.

One possible legal and policy reform to expand access to credit for farmers and potentially to smaller water providers is to securitize water savings. Companies that provide water saving irrigation technologies (like the drip irrigation company N-Drip) or water saving for water distributors (like Dexon that provide smart pig robots that detect leaking pipes) could loan money to invest in their technologies, with the loans secured by the rights to the conserved water. This would allow farmers and small water providers to access new lines of credit with their water rights and allow technology companies to provide purchase money loans that bet on their own innovations to conserve water. However, this would require reforms in water law that would allow all or part of a water right to act as collateral in a loan. Such reforms would need to address potential regulatory obstacles, like objections to sever and transfer applications or changes in diversion points and beneficial use if and when a lender forecloses on the right to conserved water. The public notice, review, and objection process to such loans, or their foreclosure, could introduce transaction costs that make such financing arrangements impractical. Inadequate or unfair public notice, review, and objection processes could pose risks for both water right holders looking to finance, and water right holders at risks from a transfer of another's water right to a lender. Still, the potential to expand credit to water users in need of water conservation technologies makes innovating in this field worth the potential risks.

Perhaps even more than smaller farms and water providers,

35. THOMPSON, *supra* note 1, at 182.

36. For a description of how some Yuma County irrigation districts in Arizona rely on bonding authority, *see Opportunities to Increase Water Storage & Conservation Through Rehabilitation and Development of Water Supply Infrastructure, and Testimony on Pending Legislation, Hearing Before the Subcomm. on Water & Power of the S. Comm. on Energy & Nat. Resources*, 116th Cong. (2019) (statement of Wade Noble, General Counsel to Welton-Mohawk Irrigation & Drainage Dist.).

Native American Tribes face a particularly acute and unique need of financing options for water infrastructure. There are 22 federally recognized tribes in Arizona, and they are diverse linguistically, economically, and hydrologically.[37] For many of these tribes, however, they have a population of small, widely distributed communities in arid and mountainous regions, making domestic and industrial water provision costly as they lack economies of scale.[38] Tribes face additional challenges. Tribes do not own their own land, but instead their land is owned and held in trust by the federal government. As such, the tribes lack potential sources of security to access credit that other water users, and even other sovereigns, have by virtue of land ownership.[39] Further frustrating tribal access to credit, tribes have sovereign immunity and thus do not have the same options to access bankruptcy laws as other borrowers.[40] This often leaves tribes dependent upon the federal government for access to resources to develop and conserve water, and pressures tribes to reach settlements in the adjudication of their water rights in order to secure funds for water infrastructure financing.

The private sector may have the ability to address some of these gaps in tribal water infrastructure finance. One possible approach is to ensure that in water rights settlements, or in settlements related to historic uranium mining contamination, tribes establish tribal corporations that hold and invest settlement funds that can be used to pay for infrastructure or secure loans. Settlement funds would have to be substantial for such tribal corporations to fully address water infrastructure needs for tribes lacking economies of scale in the water sector. A different approach might be to partner with private enterprises that provide distributed, household-level water services. Zero Mass Water (ZMW) is a company that provides household-level water augmentation with rooftop panels that use solar energy to condense atmospheric water vapor to produce drinking water.[41] The upfront costs of a ZMW panel are high (over

37. Robert Glennon, *Water Exchanges: Arizona's Most Recent Innovation in Water Law and Policy*, 8 ARIZ. J. ENVTL. L. & POL'Y 1, 11 (2017).

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

39. *See generally* Kevin Gover, *An Indian Trust for the Twenty-First Century*, 46 NAT. RESOURCES J. 317 (Spring 2006).

40. *See generally* Laura N. Coordes, *Beyond the Bankruptcy Code: A New Statutory Bankruptcy Regime for Tribal Debtors*, 35 EMORY BANKR. DEV. J. 363 (2019).

41. Miguel Helft, *Meet Zero Mass Water, Whose Solar Panels Pull Drinking Water from the*

$6,000 per panel) and might produce as much as 7 liters of water per day.[42] Those costs are likely too high for many households on reservations but could make sense with financing support from a tribal corporation with a corpus of settlement funds. ZMW technology has already been implemented on the Navajo Nation reservation, but expanding access will require more creative financing approaches.[43]

The non-profit DigDeep has shown success in bringing water supplies closer to these smaller distributed tribal communities through drilling wells.[44] DigDeep can provide more traditional distributed water sources with household level ZMW panels financed by tribal corporations with settlement trust funds augmenting the domestic supply at the household level. This is the sort of partnership between the private sector and non-profits to support water development contemplated by Professor Thompson in Chapter 9 of *Liquid Asset*. As he notes: "While not as publicly visible as private water suppliers or technology companies, consultants, foundations, and non-profits strongly influence virtually all aspects of water management. Because their activities can raise legitimacy and transparency concerns, all three groups must ensure that their decisions and activities are fully visible to the public and open to evaluation and criticism."[45] Properly structured and governed, tribal corporations can both facilitate financing while also issuing public reports to facilitate transparency and accountability in partnerships with non-profits like DigDeep and for-profits like ZMW.

IV. THE PRIVATE SECTOR & WATER DATA

Private sector entities discussed so far in this essay focus on water supply (like DigDeep and ZMW) or water conservation (like Forced Physics, TNC, Bridgestone, or Sinagua). For better or for worse, this focus mirrors much of the broader societal conversation

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Air," FORBES, Nov. 15, 2017.

42. Jeffrey Clos, *The Innovative Technology Behind Zero Mass Water's SOURCE Devise*, MEDIUM, July 25, 2023, https://medium.com/codex/the-innovative-technology-behind-zero-mass-waters-source-device-f77561ae38ff.

43. Shiva Nagaraj, *Out of Thin Air: Can Hydropanels Bring Water to Parched Communities?*, THE GUARDIAN, Oct. 5, 2021.

44. Zak Podmore, *Remote Navajo Nation Homes in Utah Have Running Water for First Time Thanks to Nonprofit DigDeep*, SALT LAKE TRIB., (July 26, 2020.

45. THOMPSON, *supra* note 1, at 204.

about water policy – focus first on demand (conservation), then on supply (water augmentation). However, this approach skips a critical step. Before we conserve or augment our water supplies, we must first understand them. This requires greater investment in water data and water system modelling. We cannot hope to know how to best invest our conservation and augmentation dollars without basing those decisions on sound data and accurate models.

Professor Thompson notes that government water regulators and managers "often work with incredibly poor information. Sometimes data is not available because it is difficult to collect or because the government does not have the funds to collect it. In other cases, the data is available but not in a usable or easily accessible form."[46] He then notes the role of the private sector in innovating artificial intelligence-enhanced smart meters as well as satellite imaging.[47] The intersection of artificial intelligence, smart meters, and satellite imagery has the potential to address one of the biggest challenges in water management – improving water data and water system modelling.

The NASA GRACE (Gravity Recovery and Climate Experiment) satellite system, launched in 2002, represents the potential future in improving water data using technology. GRACE uses two satellites; one called Tom that chases another called Jerry around the earth in orbit. These two satellites fly in formation to measure changes in Earth's gravity field with extreme precision. These changes are linked to variations in the distribution of mass on the planet, such as water in rivers, lakes, and groundwater. By observing shifts in the Earth's gravitational pull, GRACE can track fluctuations in the mass of groundwater reservoirs over time. This makes it an invaluable tool for monitoring groundwater levels, especially in regions where data collection on the ground is sparse or unreliable. As groundwater is a critical resource for agriculture, drinking water, and industry, understanding its fluctuations is essential for effective management. GRACE's ability to detect these subtle changes helps scientists monitor droughts, water scarcity, and the impacts of climate change on water resources.[48] The data from GRACE has been instrumental in understanding how

46. *Id.* at 5.

47. *Id.*

48. For an overview of the GRACE satellite system, *see* Brian F. Thomas & Jay S. Famiglietti, *Identifying Climate-Induced Groundwater Depletion in GRACE Observations*, 9 SCI. REP. 1-9 (2019).

groundwater is being depleted in areas like California's Central Valley and parts of India.[49] Its observations are used to inform water management strategies and policy decisions worldwide. GRACE has the potential to play a vital role in improving our understanding of Earth's water cycle and supporting sustainable water resource management.

The GRACE satellite system represents the sort of public-private partnerships called for by Professor Thompson in *Liquid Asset*. NASA and its Jet Propulsion Laboratory, along with the German Aerospace Center, led the development and implementation of the project from the public sector. These government partners, however, relied heavily on the investments, ingenuity, and innovations of the private sector, including contractors such as Lockheed Martin, Northrop Grumman, Boeing, and SpaceX.[50] This successful partnership opens new possibilities in the problematic realm of groundwater monitoring.

There are few universals in water policy – each river and aquifer is so different hydrologically, ecologically, socially, culturally, and legally that it is difficult to draw any universal lessons from successes or failures in any one region's water management. However, two extremely common challenges are that rural communities oppose mandatory metering of wells and often maintain illegal or unregistered wells.[51] The challenge of water metering in rural Arizona has been particularly acute.[52] The success of the GRACE system may obviate the need for such metering efforts. It may also, however, be the catalyst for expanding smart meters in rural areas. The time may be now for Arizona's rural communities to make a deal on their water data before the value of the data plummets due to advances in satellite imagery and artificial intelligence.

A political deal could be struck between farmers and Arizona's state government whereby farmers agree to record a covenant on

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49. James S. Famiglietti et al., *Satellite Measure Recent Rates of Groundwater Depletion in California's Central Valley*, 38 GEOPHYSICAL RES. LETTERS 1-4 (2011); Matthew Rodell, Isabella Velicogna, & James Famiglietti, *Satellite-based Estimates of Groundwater Depletion in India*, 460 NATURE 999 (2009).

50. NASA, *NASA Accelerates Space Exploration, Earth Sciences for All in 2024*, https://www.nasa.gov/news-release/nasa-accelerates-space-exploration-earth-science-for-all-in-2024/.

51. RHETT LARSON, JUST ADD WATER 166 (2020).

52. Brandon Loomis, *Governor's Water Council Submits Management Proposals, Already Faces Lawmaker Opposition*, ARIZ. REPUBLIC, Nov. 29, 2023.

their land to maintain and report smart meters on their wells and disclose and register the location, depth, and pumping capacity of all wells. In exchange, the state government would grandfather in all illegal or unregistered wells without penalty, and the covenant to maintain and report the smart well meter would result in a property tax reduction comparable to conservation easements.[53] Arizona's government may be willing to make this deal now with farmers to integrate smart meters into their water data and modelling, but farmers may not get such an exchange if the same data at the same level of accuracy becomes available thanks to satellites and artificial intelligence. Of course, the integration of smart meters and artificial intelligence can make critical water systems more vulnerable to hacking, but this will raise another important role for the private sector in supporting cybersecurity in the water sector.[54]

More accurate and accessible data will improve water management in indirect ways. But it might improve water management directly. A series of studies shows that when people share chicken wings or shrimp, they will share more equitably if the chicken wings have bones, or the shrimp have tails. But if people share boneless chicken wings or tailless shrimp, someone at the table will cheat and take more than their fair share.[55] The reason people will share equitably in one scenario and cheat in another is transparent evidence of consumption – if everyone can see the tails or bones on the plate, we can all monitor consumption, and social pressure will result in equitable sharing.[56] Perhaps one of the impactful innovations the private sector could provide in water management is to put the "tails and bones on the plate" by making evidence of water consumption more transparent and more easily accessible and understandable. An app on a phone that made the background of the phone red if household water consumption was above the average gallons per capita per day in your neighborhood might be just the nudge needed to change behaviors to promote

53. For an overview of conservation easements, their tax benefits, and the potential risks of such easements, *see* Jessica Owley, *Changing Property in a Changing World: A Call for the End of Perpetual Conservation Easements*, 30 STAN. ENVTL. L.J. 121 (2011).

54. *See generally* Ola Michalec, Sveta Milyaeva, and Awais Rashid, *Reconfiguring Governance: How Cybersecurity Regulations are Reconfiguring Water Governance*, 16 REG. & GOVERNANCE 1325 (2022).

55. LEE ANNE FENNELL, SLIDES AND LUMPS: DIVISION AND AGGREGATION IN LAW AND LIFE 46 (2019).

56. LARSON, *supra* note 51, at 66.

fixing water leaks or shifting to desert landscaping in Arizona neighborhoods.[57]

CONCLUSION

Professor Thompson poignantly concludes his book by noting that the private sector must recognize the inevitable role the government must play in the management of such a critical resource, and the public sector must recognize the innovations that the private sector has to offer in water management. "By actively collaborating and supporting each other, the private and public sector stand the best chance of solving the growing freshwater challenges confronting the United States and the world today."[58] Arizona lies at the forefront of that challenge and should thus be at the vanguard of partnering the public and private sector. The successes of Forced Physics, TNC, Sinagua Malt, Bridgestone, Dig Deep, ZMW, and the private firms supporting the NASA GRACE system show how the private sector has advanced water conservation, augmentation, and financing in Arizona. The law has at times proved a catalyst for these successes and partnerships with the public sector – including the conservation plans to shield farmers from forfeiture, tribal water settlements to advance financing infrastructure, and land use laws to encourage water conservation for data centers. Greater legal innovations, and far more nimble and adaptive institutions, will be required in the future to ensure such effective partnerships. Adaptations and course corrections must be guided by reliable data, otherwise these partnerships will stray into paths of wasted efforts and failed investments. The most important collaboration between the public and private sectors in Arizona, and in the world, should be in generating reliable water data to chart a path toward a sustainable water future, with the public and private sector both having a hand at the helm.

57. See generally RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS (2009).

58. THOMPSON, *supra* note 1, at 239.